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Ohio Conservancy Situation

SLOWLY the Ohio conservancy law is being put in a more and more impregnable position. Attacked in the courts and in the Legislature, it has thus far withstood the assaults of its enemies, indicating in the one case that it is probably legally sound and in the other that it represents truly the feelings of the people of Ohio. Last week the second of the Garver bills, aimed to emasculate the law by making the directors of the conservancy district elective and giving to owners of land in reservoir sites the sole right to say whether they will sell or lease the lands, was killed by the senate. There now only remains between the law and its practical use for protecting lives and property the decision of the State supreme court, already rather clearly foreshadowed in a previous contest. It is to be hoped that the final decision will be handed down shortly, in order that the great work, in the Dayton district particularly, may go ahead or that fundamental mistakes, if the court find any, may be rectified as soon as possible.

Political Turnovers

PROBABLY few heads of city departments in Chicago will retain their positions under the new administration, but it is to be hoped that those who hold office primarily by reason of their technical ability will be given a chance to demonstrate their qualifications to the incoming elective officials. If these men can work in harmony with the new administration there is no good reason to oust them and let the public and the city treasury suffer from the experimentation of the inexperienced. Engineers fill a few of the places in the mayor's cabinet—the harbor commissioner, commissioner of public service, chief smoke inspector, city electrician and city representative on the Board of Supervising Engineers, which controls the traction situation. More than political faith and favor should be considered in filling these positions if new men must be named. From indications so far Mayor Thompson is seeking disinterested counsel in technical circles. Needless to say, it is the highest duty of citizenship when engineers or their organizations are consulted in this way to give the best that is in them—disinterested advice, aimed solely to secure the public good.

Trade Commission's Opportunity

LIKE any other institution, the Federal Trade Commission must justify itself by its works. Hardly any commission or governmental body has existed for many years without so many changes in its activities, policies and scope that in its later stages its own legislative parents could not recognize their offspring. Those who created the Federal Trade Commission will no doubt have the same experience. The evolution of the commission is, to say the least, a matter of doubt, but its present activities are a matter of immediate concern. The commission can at once remove the pall that has lain upon industry since it became evident that the only way positively to determine the legality of business procedure was to go through a civil or criminal law suit. And when one obtained the desired information he might be under a heavy fine or a jail sentence or both. The trade commission will not and can not decide hypothetical cases, but it can pass upon any plan or method of doing business on the basis of a complaint, an application for a ruling, or on its own initiative, and decide whether or not a given state of facts constitutes unfair competition or amounts to infraction of law in any direction. It can, at the same time, point out what steps are necessary to cure the defects of a plan of business operation, and it can do this with some regard to business factors rather than in accordance with the strict letter of a statute. In other words the commission can act as a guide, philosopher and friend of business, instead of a prosecutor. In this lies its great opportunity. We have prosecutors a plenty. The only objection to the commission was that it would increase the supply. If it conceives it to be its duty to keep business on the rack, our last state will be worse than our first. If it devotes its energies to preserving a fair field and keeping us out of trouble it will be a blessing. No one objects to a fair umpire. No one wants any more Nemeses of business.

Newspaper Sanity

THE dismissal of Lyman E. Cooley as consulting engineer of the Sanitary District of Chicago is not a surprise to those who have followed the actions of that body for the last six months. Following the presentation of a report on water-power development, which did not meet with the preconceived ideas of what the findings should be, much abuse was heaped upon the heads of Mr. Cooley and his associates. A controversy also arose over the printing of the report. The Western Society of Engineers took action in the way of a resolution carefully stating that it did not endorse any individual but it pointed out that the public welfare is vitally affected by any pronounced attempt on the part of public officials to suppress, conceal or distort the carefully prepared opinions of experienced engineers reporting on public questions for the public interest. Further, it was held that if the findings of an engineering report are open to question, there are a number of proper and dignified procedures that can be adopted to check its conclusions. Just how much good the resolution did to sober public opinion it is impossible to tell, but the engineers were not attacked a second time in the newspapers. Instead, the Chicago "Herald" stated editorially, with reference to the "professional circulation" of copies of the report, that "much is to be pardoned to the spirit of publicity" even if the report was not such as the board approved. While publication of the report was made the excuse for the dismissal, the "Herald" is of the opinion that the weakest ground that could be imagined for taking drastic action was that publicity had been given to one side of a moot question in the Sanitary District's business. The "Herald" further believes that the board can hardly be expected to retain an employee with whom it finds itself constantly out of harmony, but that the best way to counteract what is regarded as the wrong view is not by discipline but by presenting the right view with convincing force. These statements indicate that one editor, at least, got the point which the Western Society made.

Boring Records Which Mislead

NO recent decision of the United States Supreme Court will have a more far-reaching effect in the construction field than the one rendered April 12 by Justice McKenna, in which it is held that a contractor who bases prices in a bid on boring records furnished by the engineer may recover damages if the boring records do not represent the true character of the material encountered. In the case, noted on page 554—that of Christie, Lowe & Heyworth versus the United States—the boring records, referred to in the specifications, showed only sand, gravel and clay. When work was begun, however, the material was found to consist largely of stumps, buried logs, cemented sand and gravel and sandstone conglomerate. The claimants asserted that they were misled by the erroneous information furnished them and were compelled to spend over $10,000 more than the sum named in their contract, which was based upon the materials shown by the drawings. Although the specification stated that bidders were to inform and satisfy themselves as to the nature of the material, it was admitted in the argument that the contractors did not have time to make their own borings and had to rely wholly on information furnished to them. In applying the decision to other contracts it will be instructive to learn to what degree this element of time entered into the question. In other words, can a contractor recover damages in all cases where the boring records furnished to him are misleading, or only in cases where he can prove that insufficient time was available for making his own investigations. On the whole, however, the decision will do much to remove from the contractor's shoulders a part of the burden of risk which he has been bearing for many years. It is fair to assume, also, that the case will have a broader application than merely to boring records; for the general principle involved is the same as in the case of erroneous preliminary estimates of quantities.

Union Leadership and the Contractor

LAST month the inauguration of the Federal Employment Bureau under the auspices of the Department of Labor was accompanied by discussion as to the extent to which the new system might be used in the interests of union as against non-union workers. This discussion was probably prompted by the well-known and expressed sympathies of the secretary of the department towards organized labor. Little has been heard of the matter since then, indicating, at least, that there has been no flagrant misuse of the power of the bureau. Nevertheless, there is no doubt that organized labor had hoped that such a plan would redound to its benefit.

Many of the unions are in need of better leadership, but of a kind that does not exercise its influence through a hold on legislators or public officials. The leadership needed is that of more intelligent and loyal officers in the local chapters. Many of the construction unions have men of real ability as national leaders. Instances keep cropping up, however, that convince one that a better appreciation of local conditions and of the purpose of the labor movement as a whole is sadly wanting in the direct leadership of the rank and file. There is the instance of a Chicago local of a building-trades union which had an agreement with a local manufacturing firm (for consideration received) to prevent all manufacturers of a certain product, except this firm, from putting their goods into the construction of any Chicago building. This local was threatened with expulsion by the national organization and forced to repudiate the agreement. There is the instance of a St. Louis local which called a strike on a building job because four members of the New York local of the same union were employed on the building, when it was known to those connected with the work that every member of the St. Louis local was employed, and that some of them, in violation of all union principles, were working sixteen hours, or two working days each calendar day—one shift on one job and the second on another—because it was against the policy of the local leaders at that time to increase the membership. There is the case of a Chicago union, covering a trade allied to one that had never been practised before in that city, which was unable to handle the new work through its members, but still made conditions exceedingly vexatious for the New York union called on to supply men for the work.

Contractors do not object to unionism in theory. Many of them favor it in practice, but they deplore the uncertainty so often obtaining in the conduct of a job with union labor. Demands for higher wages which were not foreseen when the contract was figured, shutdowns caused by disputes of the unions among themselves, or by some delegate taking an exaggerated stand over some trivial matter susceptible of adjustment by a far less expensive method than a strike, should be prevented by the unions themselves. Wiser and more patriotic local leadership, and a general participation by the members in the union's affairs, that they may help shape the policy and be in a position to back their local leaders intelligently, are the only sure solutions. This journal knows of one delegate, managing the affairs of a New York local of a building-trades union, with whom every contractor enjoys dealing. This man appeals to the intelligence of the members of his local, has been present at important meetings and is sure of support in every fair position he takes. He handles incompetent and dishonest workmen without gloves, and appreciates that the contractor as well as the union must live. He has done more with these methods, it is safe to say, than any labor leader in New York ever did without them.

Six and Eight-Inch Aggregate

WITH the general thesis of the article by Edward O. Keator, on page 556 of this issue, engineers generally will probably be in hearty agreement. They may foresee great difficulties in handling concrete containing an aggregate of a maximum size of 5 or of 6 or of 8 in., but they will probably readily admit that the resulting concrete, providing the handling problem can be properly solved, will be cheaper and stronger than a mixture containing smaller-size aggregate. The article is one that should receive a great deal of attention, for it represents an advance in the right direction.

With some of the statements made by Mr. Keator, however, there will be rather strong disagreement. For example, the statement that strength varies as the cube of the maximum size of the aggregate would need very thorough study before unqualified approval could be given. On one point, in particular, this journal must dissent with Mr. Keator. The point, however, is one that should be discussed. Mr. Keator recommends the use of very large aggregate for concrete pavements. Is there not danger that wedge-shaped volumes of mortar on either side of the exposed portion of large aggregate will quickly chip away and allow a hole to be worn in the pavement? Moreover, a stone extending practically through the pavement from top to bottom makes a point of cleavage through the whole slab, and if the bond of the mortar with the stone is not strong and there are other large pieces of aggregate fairly close, there is afforded an excellent place for the development of a vertical cleavage plane. Such a pavement would probably show more cracks than one using smaller aggregate. Moreover, in a careful study made recently by one of the contributors to this journal, a very thorough student, those pavements were found to be in best condition where the maximum amount of stone surface was exposed. In other words, the closer a pavement approximates a mosaic the greater its resistance to wear, due undoubtedly to the exposure of the maximum amount of hard material.

With Mr. Keator's strong protest against careless mixing this journal is in hearty accord. The folly of "a batch a minute" was strongly pointed out by N. C. Johnson in his series on the application of the microscope to the study of concrete, while careful engineers generally bear evidence to the poor quality of work obtained when the mixers are pushed to the utmost capacity.

The Engineering Record trusts that Mr. Keator's article will occasion considerable discussion on the subject of large aggregates. With the general idea it is in hearty accord. It should be remembered, however, that even with the large aggregate grading must not be neglected. In other words, the mere dumping of some 6 and 8-in. plums into concrete the maximum aggregate of which, otherwise, is of 2-in. size will not help much to secure greater density and greater strength.

Sane Ventilation Report

WHEN the Chicago Commission on Ventilation started to work in 1910 it subscribed to certain resolutions which referred to facts as demonstrated to the satisfaction of the members by past experiment and by new tests carried out in the course of the commission's investigations. In the report just issued sixty-eight of these resolutions have been set down as a sort of creed or "confession of faith." The very first one states that carbon dioxide, the convenient chemical constituent in foul air which has always been the scapegoat, is not the harmful agent of major importance in expired air. This fact has been demonstrated only a few years ago, and reaffirmation at the head of the list indicates general acceptance by sanitarians of this important fact. The next notable resolution is that for adequate ventilation smaller volumes of air suffice when introduced by currents than when introduced by dilution. Then the almost obvious statement is made that the delivery of a certain volume of air per unit of time per occupant into a given space does not necessarily constitute ventilation. Any operator of a settling basin for turbid water who has had trouble with "short circuits" from inlet to outlet will agree to that proposal. The ventilating engineers, just like the filtration experts, have learned that to get complete displacement a fluid must be admitted and taken away from a container by widely separated openings.

Going back to the resolutions, relative humidity and bacterial content are considered the important factors in ventilation. Heating and ventilation are emphatically characterized as two distinct problems, and neither should interfere with the efficiency of the other.

The more concrete of the resolutions refer to car ventilation, theaters and school rooms. For street cars or sleeping coaches the plenum system without outlets, or vacuum system without inlets, is incompatible with a high degree of efficiency. Not less than 500 cu. ft. of air per hour per occupant is considered essential in cars making frequent stops. For coaches and other cars twice this amount is desirable. Sash ventilation is condemned and a minimum temperature of 50 deg. Fahr. is recommended. School children should receive 30 cu. ft. per minute, and the relative humidity should not fall below 40 per cent.

Probably the most important work of the commission has been the establishment of the comfort zone idea on a firm scientific basis. The relation between humidity and temperature has always been known, but the investigators have now worked out a chart with definite limits. Temperatures of 64 to 70 deg. Fahr. and corresponding relative humidities of 55 to 30 per cent are the figures. Based on these limits designs for the equipment to ventilate gathering places should be easily arrived at. This idea and other definite conclusions which have been determined upon only after serious consideration and by experiment are sure to be given the most careful attention by the ventilating engineer. With such important conclusions in its archives it is only regrettable that the commission has waited until the fifth year of its existence before making them public.

Shouldering their Responsibilities

IT is with much satisfaction that the Engineering Record prints on page 561 of this issue the recommendations made by a joint committee of Engineers to the New York State Constitutional Convention now in session, for it indicates that the engineers of the Empire State have willingly performed their duty as citizens, and that all of the great national engineering societies, through representative members, can get together to work for an important end. The recommendations sent to the delegates to the convention have the official endorsement of the American Society of Civil Engineers, the American Institute of Electrical Engineers and the American Institute of Consulting Engineers. Members of the American Society of Mechanical Engineers and the American Institute of Mining Engineers, sitting with the joint committee, fully endorsed the recommendations though not empowered to sign them officially as representatives of their societies. Certain of the societies have before this acted together, and all of them were represented on the joint committee on the licensing of engineers, which, however, took two years to reach a conclusion. The committee on the constitutional convention, on the other hand, was composed of members of all the great societies and was in session less than a month. The fact that they have been able to get together presages still closer relations between the great national bodies—which is much to be desired.

The logic of this action of the engineers need not be presented to the profession. Its members realize more fully than any other class of citizens that few functions of government are of more importance than the administration of public works and the regulation of public utilities. With them can rank only education and the safeguarding of the public health. As far as cost is concerned, in most States and cities the expenditures on engineering work exceed those for any other class of undertaking, with the possible exception of education.

Contrasting strongly with the importance of good administration of public engineering works is the absurd system of completely upsetting departments with every new administration of a different political faith. This upheaval has been all the more detrimental in New York because the term there is only two years. Under such procedure continuity of policy and the development of capable, experienced men is almost out of question. For that reason the pamphlet sent to the delegates to the convention lays especial stress on the necessity for long tenure of office of those having charge of engineering work, the term for the three commissioners of the proposed Department of Engineering and Public Works being set at twelve years each. In the Department of Public Utilities the commissioners would serve ten years each, if the Joint Committee's recommendation be adopted.

Question is sure to be raised as to the advisability of putting the Department of Engineering and Public Works under a commission rather than under a single head. While in the discussion at the house of the American Society of Civil Engineers on March 17, the opinion was freely advanced that the most efficient administration is secured with a single-headed department and while many of the members of the joint committee held the same view, it was believed impossible to insure stability with this type of organization. With the three-headed commission, on the other hand, each incoming Governor would be able to appoint only one member of the commission, and the other two could be depended upon to support the traditions of the department, prevent the overthrow of its policy and the destruction of its organization. Those long experienced in State work were the most emphatic in their advocacy of this provision, even while they granted that under ideal conditions the single-headed department with a strong incumbent leads to greater efficiency.

The recommendation which is most likely to meet with serious opposition in the convention, though it will receive the ready endorsement of engineers, is that which provides that one-third of the membership of the board or court of claims be composed of engineers. Here again, to the engineer, the argument is obvious. Well over 90 per cent of the claims coming before the claim-adjudicating body in New York State are of an engineering nature. What more logical, then, than to have men who appreciate the technical questions involved to pass upon them? It is morally certain, nevertheless, that the lawyers in the convention, hide-bound by the idea that only a lawyer can be a judge, will resist to the utmost the departure of making lay members eligible to the court. Engineers, however, cannot properly be considered as lay members of a court of claims, for in over 90 per cent of the cases they are as truly experts and specialists as the lawyers themselves. Despite the strong opposition that will develop against this recommendation it is one for which engineers should fight most strenuously. If they can once establish their position in the law of New York State as being qualified for judicial honors they will have made the greatest gain possible in their relations to the public.

There are other recommendations that merit most careful consideration. Some of them will have to be amplified and modified, and for that reason the committee is only at the beginning of its work. It must be prepared to go before the various committees of the convention, to spend long hours in building up arguments and in presenting them to the delegates. For this, the Engineering Record believes, the committee is fully prepared. It will deserve well of the profession for the discharge of its heavy duties.

But the committee should not be alone in its work. It is the duty of every engineer in the State to communicate with the delegates from his particular district and to see that they fully understand the import of the recommendations and the reasons for supporting them. Local engineering societies throughout the State are in an especially strong position to bring influence to bear upon the delegates to the convention. Individual engineers who are unable to learn, through their local papers or otherwise, the names and addresses of the delegates from their district can obtain the information from the joint committee, which can be addressed 220 West Fifty-seventh Street, New York City, or can obtain it by addressing this journal.

The participation of engineers in the convention is but another indication of the future that lies before the profession in this country. In the past problems of governmental organization have been to the fore, and so great were the opportunities in private enterprise that the cream could be skimmed with but little attention to the engineering side but with strong emphasis upon the business organization and affiliations. Both in Government and in private affairs, therefore, the lawyer was to the fore. The times are changing. Material development is now most important in the success of any industry, and the large corporation which has not its research divisions is put down as unprogressive. In Governmental affairs, moreover, the people are demanding greater efficiency, and in the administration of their engineering affairs this means the replacement of lawyers, merchants and professional politicians by those fully qualified to handle the engineering questions involved in the building and operation of great public works. Such was not the case twenty years ago and for that reason the people of New York, if these recommendations can be brought to their attention, will demand such constitutional provisions as will insure the efficient administration of their great public works and the sane, scientific supervision of the public utilities over which they have assumed regulatory control.

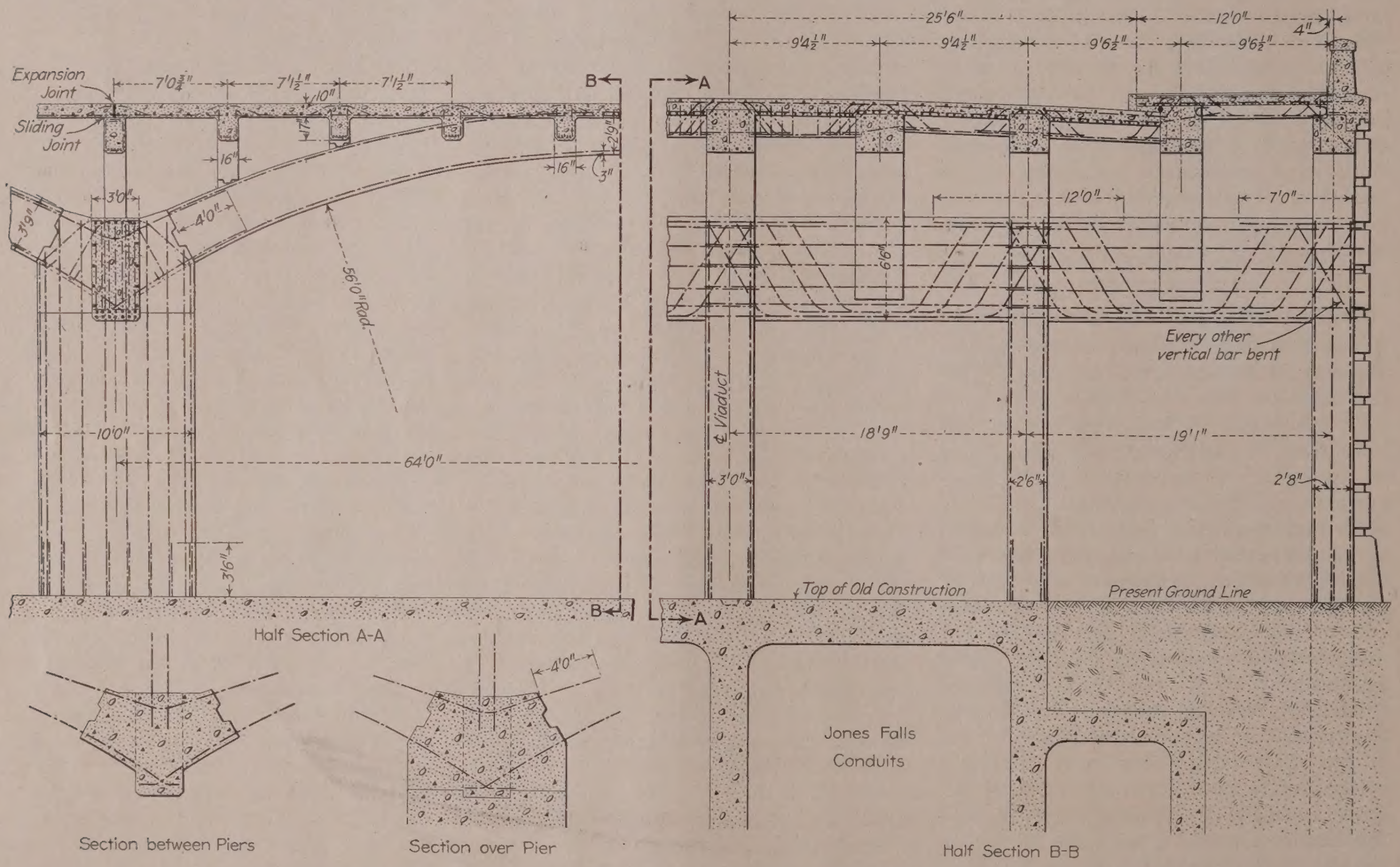
Fallsway Viaduct in Baltimore Built on Sharp Curve with Concrete from 205-Foot Tower

Ribbed-Arch Structure in the Jones Falls Improvement Supported Above Concrete Conduit and Poured from High Central Towers Served by a Single Mixing Plant

SEVERAL unusual design and construction features were adopted in the new Fallsway Viaduct in Baltimore, which completes the conversion of the old Jones Falls open drain canal into a main north and south trafficway through the city. Some of these features are the flying arches springing from transverse girders between the main piers, difficult curve, grade and skew details for the arches over railroad tracks, the two high towers for the delivery of concrete—one 205 ft. high to serve about 770 ft. and the other 180 ft. high to serve 650 ft. of the length of the viaduct, and the use of one central mixing plant for the entire job.

Previous work on this project embraced the construction of a flat-roof conduit along the bed of Jones Falls, which flows through a closely-built manufacturing and commercial district to the waterfront. The roof of this conduit provides a 75-ft. highway known as the Fallsway. The new viaduct, which has a total length of 1680 ft., is built on top of the conduit on a 3½ per cent grade to pass over the Pennsylvania Railroad tracks with sufficient clearance and connect the Fallsway with Guilford Avenue and adjacent uptown streets, which at this point are about 50 ft. above the stream and the tracks following its course.

The new construction comprises an earth-fill approach with reinforced-concrete retaining walls and a series of ribbed arches which follow a curving alignment on a curve of 400-ft. radius for a portion of the length. The accompanying artist's drawing shows a bird's-eye view of the new construction, which will create a broad direct route on easy grades between the waterfront, the railroad terminals and the city proper. It avoids the steep hills which are met on the other main traffic streets coming through the business section.



SECTIONAL ELEVATIONS OF TYPICAL ARCH SPAN, SHOWING REINFORCEMENT AND FLOOR DETAILS

VIADUCT BUILT ON TOP OF LARGE CONDUIT

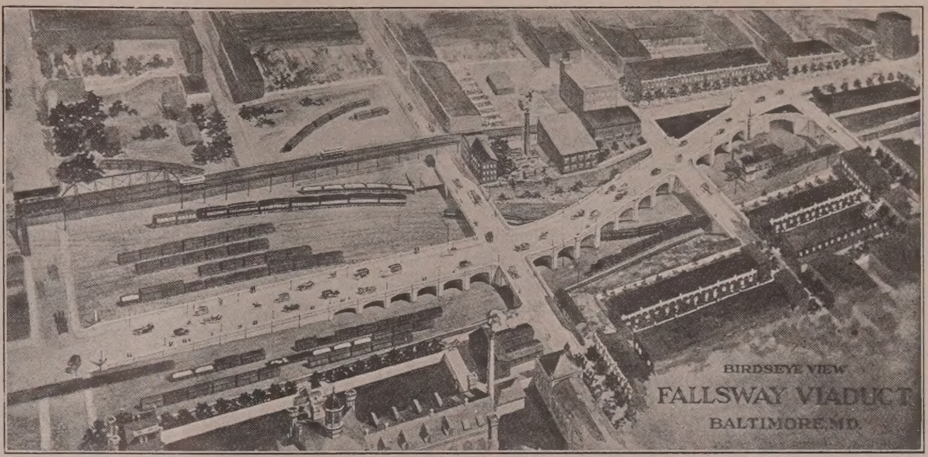
Throughout its entire length, the viaduct is built directly above and resting upon the Jones Falls conduit. Its lower end meets the grade of the conduit roof in the freight yards of the Pennsylvania Railroad and the Western Maryland Railway. The street grade then rises on the viaduct, while the conduit continues beneath the yards and tracks in a common structure with the viaduct, to which it is connected as part of the necessary foundations.

The Jones Falls conduit is of a rectangular three-barreled section, consisting essentially of twin barrels 20 ft. wide and 15½ ft. high, and a third barrel 16 ft. wide by 15½ ft. high on the easterly side for dry weather flow. The vertical walls are all 24 in. thick, are carried to rock, and have an invert 18 in. thick laid between them. A roof 2½-ft. maximum thickness spans these walls. Through this structure it is necessary to distribute the loads of the viaduct, a condition which gives rise to a number of special points of design.

GENERAL DIMENSIONS AND DESIGN FEATURES

There are seventeen arch spans of 54 ft. to 64 ft. in the viaduct proper, aggregating about 1200 ft., and an approach section 480 ft. long on earth-fill between retaining walls. At one point, Eager Street, there has been incorporated into the structure an old stone arch, spanning Jones Falls at right angles to the present arches. The viaduct is designed for a loading of 60-ton double-truck electric cars on two tracks. A typical span of one of the standard lengths, as indicated on the accompanying half sections showing details of the construction, has nine segmental circular arch ribs, five of which spring from piers of the same width as the ribs, while the remaining four spring from deep transverse girders between the piers.

Three of the five piers are built as upward extensions of the walls of the twin barrels in the conduit, while the two outside piers go down to rock on separate foundations already built outside the conduit. The piers are in most cases from 2½ x 10 ft. to 3 x 10 ft. in section, the smaller dimension being fixed by the 2-ft. conduit wall and the long dimension being sufficient to provide proper bearing area. The construction of the conduit wall be-



GENERAL VIEW OF VIADUCT—CURVE AND GRADE COMPLICATE CONSTRUCTION

From a copyright artist's drawing by Louis A. E. Plitt.

neath the piers is the same as elsewhere, except for the provision of keyways for bonding and reinforcement ties.

The transverse girders between the piers carry at their midpoints the skewbacks of the intermediate arch ribs, which thus become flying arches. These arches cannot be brought to direct foundations, since their center lines are above the roof spans of the conduit. The springing lines of arches in two adjacent panels on the intermediate lines of ribs are at a common level, so that their horizontal thrusts against the transverse girder are balanced for equal loading, while the vertical loads are carried over to the two supporting piers. A typical section of the transverse girders is 3 x 7 ft.

The arch ribs are from 2½ ft. square to 2 ft. 9 in. by 3 ft. in section at the crown. The 10-in. floor slab, with floor beams cast integrally with it in T-section, is carried on the arch ribs by direct bearing of the beams near the crown and through 16 x 20-in. columns elsewhere. On the outside lines of arches there are solid spandrel walls.

Over each line of piers there is a transverse expansion joint in the floor, and here the "T" floor beam is replaced by a deeper simple beam on top of which the slab ends slide freely. Here, also, vertical expansion joints are provided in the spandrel walls. One of these joints starts at the top of the skewback of each arch and runs upward along the edge of the pedestal surmounting the pier, the joint being concealed by an offset in the rustication finish on the face of the bridge.

SPECIAL CONSTRUCTION DETAILS

On the curve above Eager Street, where three tracks of the Pennsylvania Railroad are crossed and provision made for a total of five future tracks, the piers are built on a skew of 40 deg., and arch spans of variable length are introduced in the adjacent panels. In these latter panels, the arch rib on the outside of the curve is of full span and the successive inner ribs are of shorter spans down to about 30 ft., where straight beams 4½ to 5 ft. deep are substituted.

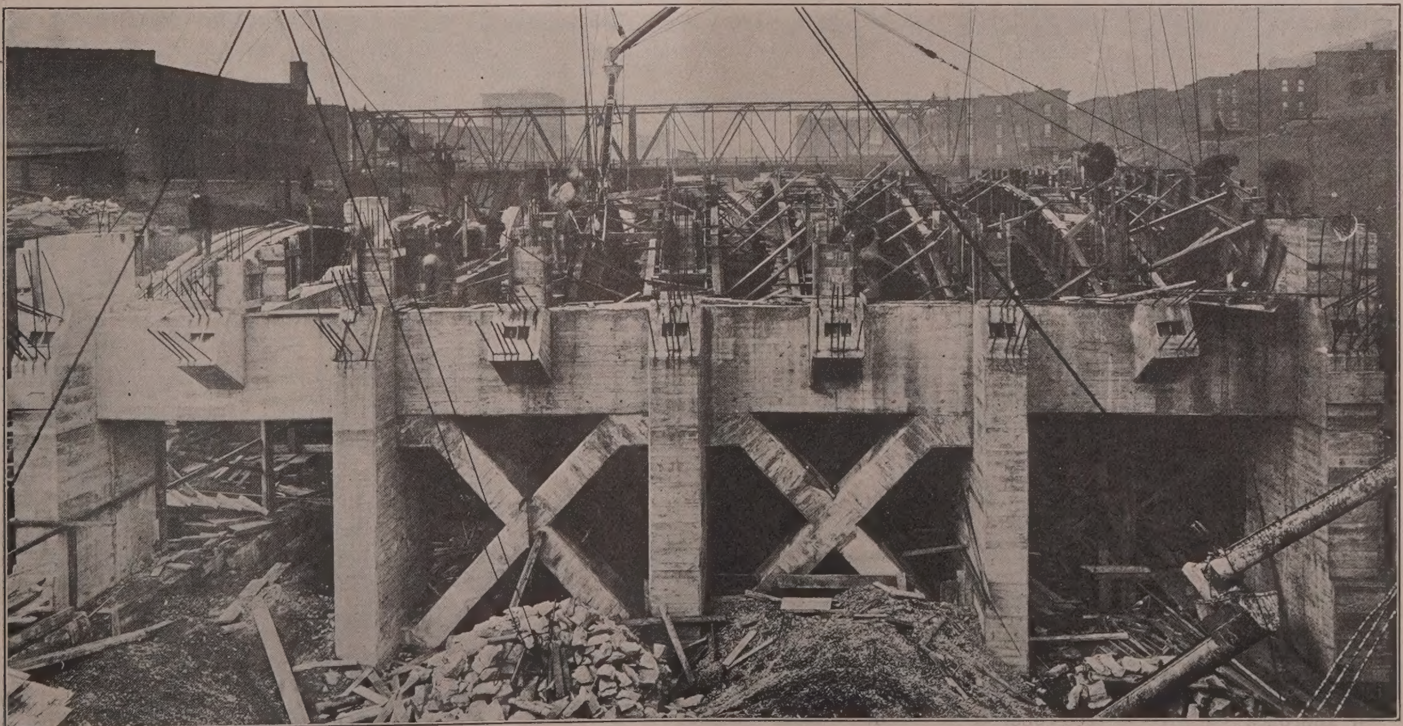
In the skew panels, the arch construction is similar to that in the normal panels, but the placing of the skewbacks is complicated by the fact that the combination of curve and grade in the bridge at this point gives each a different elevation. Likewise, the nine arch crowns in a panel are each at different elevations. Four of the transverse lines of piers affected by the curve of the bridge line have X-bracing between their three center piers, as shown in one of the photographs. This is to take care of the overturning component of the arch thrusts. On each of these lines of piers, also, a buttress is placed against the outer conduit wall to transmit the overturning thrust to solid rock.

Just south of the curve there is a special construction where the old Eager Street stone arch remains intact within the new viaduct. On each side, the new arches are sprung from abutments of similar cross section to the standard piers. The backs of these abutments in turn bear squarely against the side faces of the stone arch. The transverse girder for the flying arches is also required at these abutments, and the thrust against it is transferred by short heavy struts to a second parallel girder built against the stone face so as to distribute the load over a large area.

APPROACH SECTION BETWEEN RETAINING WALLS

The solid fill approach to the viaduct at its lower end is between reinforced concrete retaining walls running from zero to 15 ft. in height. The wall proper has a thickness of 20 in. and is reinforced as a beam between 30-in. bell-crank counterforts, 27 ft. apart. Each counterfort rests upon 2½ x 6-ft. piers and the end of the bell-crank arm is tied into the top of the conduit. At every alternate counterfort there is a ½-in. expansion joint extending down the face of the wall and throughout the center line of the counterfort, and concealed on the face of the wall behind an offset in the rustication.

To improve the appearance of the viaduct, the outside faces of the piers, arches, spandrels and parapet walls are ornamented by rustication and paneling to break the flat surfaces. A 2-in. chamfer



INTERMEDIATE RIBS SUPPORTED BY TRANSVERSE GIRDERS—CROSS BRACING AT CURVED PORTION is used at the corners of piers and lower exposed edges of arches, girders and floor beams. All exposed flat surfaces are bush hammered up to within 1 in. of edges and corners, a ribbon of smooth concrete being left there to improve the appearance and to avoid chipping in hammering.

A special effort was made to bring the stone of the body concrete to the surface, so as to expose the dark faces of the stone in bush hammering. For this reason, the concrete was thoroughly tamped against the forms from behind without spading. The parapet was cast in place, with vertical expansion joints at a maximum distance of 14 ft., and its coping was cast on it in sections 4 ft. long. After hardening, the coping was finished by rubbing with a carborundum brick.

CONCRETE DISTRIBUTION THE PRINCIPAL CONSTRUCTION PROBLEM

In the construction of the viaduct, the principal problem was the placing of concrete over such a large area with little available working space on the ground among the railroad tracks, cross streets and other obstacles. Tower distribution was adopted, one 205-ft. timber tower, shown in the photograph, being erected at Eager Street beside the old stone arch, and a 180-ft. tower at Chase Street, 550 ft. beyond. Chutes from the first tower served the entire section from the head of the retaining walls, 370 ft. below it, to Chase Street, 400 ft. above, while the second tower served the remaining 500 ft. at the upper end of the viaduct and also 150 ft. below Chase Street. On account of the cramped working space at the foot of the tower at Chase Street, no concrete was mixed there, but the concrete from the Eager Street tower was delivered to the Chase Street hoist, raised again and shot ahead through the chutes.

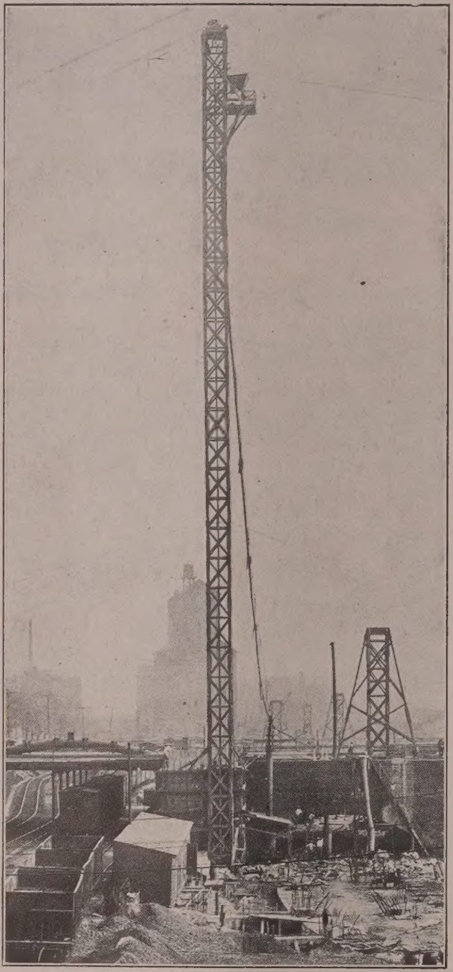
One mixing plant thus served the entire job, except for minor operations. It was located beside the Pennsylvania Railroad tracks at the foot of the Eager Street tower, where some of the material was unloaded directly from the cars into a bucket elevator which conveyed it to the bins. The remainder of the sand and gravel was hauled in motor trucks and dumped into the bins, which were near street level. The mixing plant was equipped with a 1/3-yd. concrete mixer and both of the towers with distributing systems. Hoist buckets of 1/3-yd. capacity were used and the hoppers at the heads of the towers were capable of holding two or three bucketfuls.

The flow into the 10-in. three-quarter-round chutes was controlled by a gate and operator on the tower. It was found desirable to maintain practically a constant slow stream of concrete in the long chutes, for which the gate control was essential. To supply this concrete effectively, the bucket hoist was speeded up by lagging out the drum of the hoisting engine until a round trip could be made in about 45 sec. The maximum rate of placing concrete was about 160 cu. yd. per day, since the yardage in most of the sections was relatively light.

At intervals of about 50 ft. along the main chute, vertical outlets were provided for connecting a secondary lateral chute to reach intermediate points. This chute was in two trussed sections, one suspended between the connection and a secondary cable line on 40-ft. towers, 40-ft. from and parallel to the main line, and a second 50-ft. section of chute swiveled at the point of suspension from the secondary cable, so as to reach any point on its radius.

POURING RIBS AND HANDLING FORMS

The arch ribs were poured from the crown so as to build up simultaneously on both sides, and four or five in one panel were usually finished in one day and the remainder the next day. Timber arch centers were used, three complete sets being employed for the shorter arches and two sets for the longer ones. The same centers were used for the 57-ft. spans as for the 54-ft. spans, the two ends being lagged out to fit. South of Eager Street, these centers were handled intact on rollers beneath the arches and by a locomotive crane in moving forward. North of that point, the presence of railroad tracks prohibited this method, so it was necessary to strip the lagging from the trusses, of which there were four to each rib, and to move the trusses ahead by hand. They were then reassembled in pairs and raised by a tripod mounted on a flat car of 10-ft. gage. The variable spans of the arches in this neighborhood also made the dismantling of the forms necessary.



HIGH TOWERS AND LONG CHUTE SERVED BY A SINGLE MIXING PLANT

Forms for the floor slab were supported from the arch centers. The requirements for striking forms called for the arch centers to remain in place 21 days, at which time the pouring of the floor was permitted, and then the floor forms were required to stand 10 days. The arch centers were thus in place about 30 days.

Class A 1:2:4 concrete was placed in all parts of the structure above the foundations, using either gravel or stone except in the outer piers and arches, where trap rock only was used. There were 14,000 cu. yd. of this concrete, 4100 cu. yd. of which was facing concrete. About 800 tons of square corrugated bars made up the reinforcement.

The total contract price for the viaduct, above the foundations, was $190,000. The unit bid prices on the concrete were $8.90 per cubic yard for the general Class A and $9.25 per cubic yard for facing Class A.

The Fallsway Viaduct was designed and erected under the general direction of Calvin W. Hendrick, chief engineer of the Baltimore Sewerage Commission, who was also consulting engineer in charge of the general Jones Falls improvement. Theodore Wells Pietsch prepared the architectural treatment of the structure. The work of design was under the immediate charge of W. A. Megraw, and the construction in charge of C. K. Allen. The contractors were Claiborne, Johnston & Company, of Baltimore, for whom Elliott Van Devanter was supervising engineer.

Kansas City Tries Thin Brick with Sand-Asphalt Surface

New Form of Vertical Fiber Block, Having 3-Inch Depth, Used on 16,000 Square Yards of Street

By CLARK R. MANDIGO
Assistant City Engineer, Kansas City, Mo.

IN NOVEMBER, 1912, the Western Paving Brick Manufacturers' Association adopted a new form of brick block, termed vitrified vertical fiber paving block. The block is approximately 4 x 8½ in. by from 2½ to 4 in. in depth. The 4 x 8½-in. faces are wire-cut and laid as the wearing surface, the lugs being formed by the die on one side for the full depth of the block. The association recommends the 3-in. depth block for all medium and heavy traffic streets, but manufactures 2½, 3½ and 4-in. depth blocks to cover all classes of streets, from country roads to heavy traffic city streets.

ADVANTAGES CLAIMED

Some of the advantages claimed by the manufacturers for vertical fiber brick may be enumerated as follows:

1. The brick may be readily adapted in depth to the kind of traffic street to be paved.

2. The 3-in. depth vertical fiber is more durable than the standard 4-in. repressed block, because (a) a brick surface which wears down 1 in. will be rough enough to need resurfacing and the 3-in. vertical fiber can sustain this wear without breaking as well as the 4-in. repressed block; (b) the non-repressed paving block is stronger and more uniform than the repressed; (c) the fiber of the clay, as it comes from the die, is set vertically in laying the finished brick in the street, thus decreasing liability to shell or split; (d) a smoother surface is obtainable than with any other form of paving brick, as all kiln marks occur on the sides and not on the wearing surface; (e) the square edges and reticuled surface make the joint filler more durable, preventing the brick from chipping and getting rough.

3. By the use of an asphalt filler and surface carpet, all objections to brick pavement on account of noise, color, etc., or difficulty with expansion are done away with. The paving is less noisy, even with cement

grout filler, on account of its greater smoothness and close square-edged joints.

4. Although designed primarily for an asphalt filler, the vertical fiber brick is equally well adapted to cement grout filler, and for both kinds of filler superior to the round cornered repressed block.

5. In addition to the above advantages of the vertical fiber brick over the standard paving block or side wire-cut block, there is the decrease in cost on account of decrease in depth of subgrade, in amount of brick material per square yard, in freight on the material, and in labor of handling and laying, only 32 to 35 brick being required to the square yard, instead of 41 to 44 of the standard-sized blocks.

While these are the claims of the manufacturers, they have been so well substantiated by service tests that nearly a million square yards of vertical fiber brick were laid in the western central States during 1914. The idea of laying brick flatways originated, the writer is informed, with the success of a 2¼ x 4-in. vitrified paving brick laid flatways, making a 2¼-in. depth of wearing surface, on a street in Greenville, Texas. The pavement is cement grouted and a close inspection recently failed to reveal a broken brick, although the pavement has been in use for 10 years and is fairly well worn.

Kansas City, Mo., laid 16,000 sq. yd. of 3-in. vertical fibers with asphalt filler during the 1914 season. One of the streets laid receives an estimated traffic of over 500 horse-drawn vehicles per day and has given perfect satisfaction, the asphalt carpet being intact at the end of six months' wear.

ASPHALT CARPET WEARING SURFACE

The writer considers the asphalt carpet on top of the pavement an incident to an economical method of filling the joints full and not as an essential part of a good, durable or satisfactory pavement. The asphalt surface does, however, add to the desirableness of the brick pavement for certain classes of city streets, and if properly placed can be maintained indefinitely at a very small annual cost. The asphaltic cement used for filler should be of the best quality, high in ductility and of a penetration of not less than 80. It should be applied very hot on the warm, dry, pavement and brushed back and forth with rubber squeegees until the joints are full, only a thin coating being left on the surface.

The filling of the joints should follow close behind the laying of the brick so as not to allow fine dust to accumulate on the surface and destroy the bond between the brick and the asphalt. After the asphalt has been applied, it should be sprinkled with clean, coarse, dry sand. It is best to roll this sand into the asphalt and broom off the surface before throwing the street open to traffic. Experience has shown that the asphalt carpet will last from one to three years. It may be maintained by applying asphalt in the same manner or by the use of California asphalt road oil as described for macadam streets in Engineering Record of Dec. 12, 1914. The rough reticular surface of the vertical fiber brick affords an excellent bonding surface for the asphaltic cement.

In recent specifications the writer has required that the vertical fiber brick be manufactured with lugs not exceeding ⅛ in. in height, his idea being to use an asphalt filler on a close-jointed brick pavement. The narrow joints make a smoother, easier riding pavement with a minimum chance for chipped edges. Vitrified brick are never true enough to form but that the joints in a lugless pavement will be wide enough to receive the liquid asphalt, or cement grout.

ABRASION TEST REQUIREMENTS

In drawing the specifications for 3-in. vertical fiber paving brick an allowance of 2 per cent was made for the square corners and the brick was required to show 24 per cent or less abrasion loss in the rattler. From a large number of comparative tests made at various manufacturing plants and from tests made on brick furnished for contract, it appears that such an allowance is not necessary from the standpoint of the manufacturer. About the same percentage of the kiln can be furnished under a 22 per cent test for the wire-cut brick as a repressed block under the same test. Since the square corners are a disadvantage in the rattler test, the conclusion is that a harder, tougher brick can be made of the vertical fiber type at no increased cost. The average loss for the 575,000 vertical fibers laid in Kansas City in 1914 was less than 22 per cent on a 24 per cent specification, the brick coming from three different Kansas plants. Where 2½-in. depth block are used the requirement should be 24 to 26 per cent to allow for broken brick in the rattler, while a 21 per cent specification on a 4-in. depth block can be filled without trouble.

In cost the vertical fiber 3-in. block has shown a saving of 15 to 20 per cent over the 4-in. repressed block. The 4-in. depth vertical fiber with asphalt filler costs a little less than the 4-in. block with cement grout filler.

The vertical fiber brick have become very popular in the western central States. The pavement is certainly more pleasing in appearance, smoother and less noisy than the repressed block. The brick have superior wearing qualities and there is no doubt but that the pavement will be more durable. The use of a brick less than 3 in. in depth is not advisable, except on streets where there is little travel, until the life of a 3-in. brick can be more closely determined. It is the writer's opinion, however, that a 3-in. vertical fiber brick will give as long service and be a better pavement during its life than the 4-in. repressed block. To those engineers who prefer a bituminous filler for brick pavement the new brick should especially appeal. On account of the square edges to the brick, a cement grout filler will not have a feather edge body at the top of the joint and will consequently not chip out as readily.

The vertical fiber brick of proper depth appear to be a valuable addition to the materials used in paving country roads, streets in towns, or outlying streets in cities, and at the same time an important improvement over the old repressed brick block as a city pavement for heavy traffic streets.

New Design Proposed to Protect Points on New Jersey Shore from the Sea

Chief Engineer of Harbor Commission Recommends Heavy Box-Like Sand-Filled Timber Bulkhead with Sloping Face and Special Anchorages

AS A RESULT of a study of the most successful forms of coast protection in England, France, Holland and elsewhere, and of the weaknesses developed in the existing works along the New Jersey coast by the severe storms of the last two years, B. F. Cresson, Jr., chief engineer of the New Jersey Harbor Commission, has presented a design for a radically different type of bulkhead from any yet used in that State. The design was prepared to meet the specific needs at Longport, a short distance south of Atlantic City, and at Stone Harbor, farther south. Features of the bulkheads proposed are a sloping instead of a vertical face; a projecting lip for further lessening the impact of heavy waves; a tight box-like cross-section behind the bulkhead filled with sand to provide weight, and an apron at the toe with anchorages formed by inverted piles. Groynes at intervals, so designed as to permit building up with planking as the beach rises, are a part of the plan.

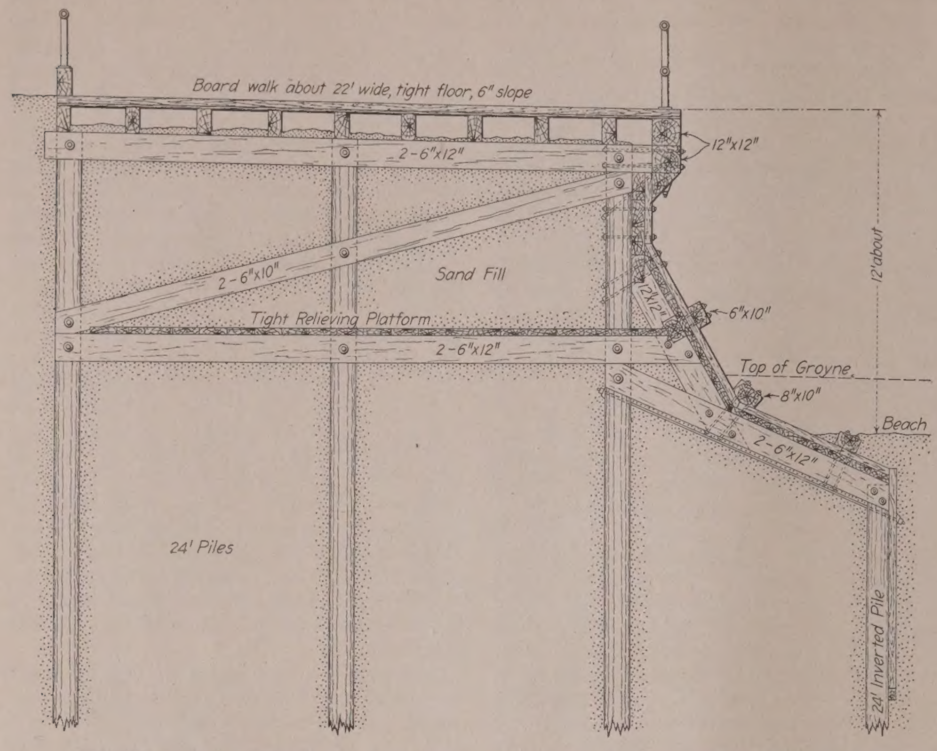
Details of bulkhead and groyne are shown. In his report to the commission Mr. Cresson explains the design and the reasons therefor. His conclusions and recommendations are presented practically in full.

BULKHEAD

Giving consideration to the conditions at Longport and Stone Harbor, to the opinions of the mayors of these boroughs, their engineers and superintendents, and to the studies which have been made of what has been accomplished in protecting the sea coast at other points, a bulkhead has been designed of timber with the face inclined to the vertical and with certain of the walings on the outside so as to break up the receding waves and thus minimize the scour. A tight platform has been planned behind the top of this bulkhead in order to protect its back from the water. It would be most desirable to give this bulkhead weight by piling in it large quantities of riprap and heavy stone, but the cost of stone at Longport and Stone Harbor is very great and we have sought to obtain the same results in another manner. A platform has therefore been added near the bottom of the bulkhead on which sand is to be piled and thus add its weight to the bulkhead to aid in preventing its overturning. This platform is perhaps a novelty in this type of bulkhead construction, but it has been used in some of the bulkheads in New York City, and in some of the works recently constructed in Boston harbor.

Means must be found to add weight to this structure, otherwise it will be overturned and lifted in the same manner that many of the bulkheads have been lifted and overturned along the New Jersey coast in the recent storms, and with a stout relieving platform of this type the writer believes that this difficulty will be overcome.

In order further to safeguard against the possibility of underscour, sheet piling is recommended from the toe of the apron to a depth of 8 ft. It seems unlikely that there will be sufficient erosion to get below the toe of the apron, but in case this does



BULKHEAD WITH RELIEVING PLATFORM, SLOPING FACE AND SPECIAL ANCHORAGE

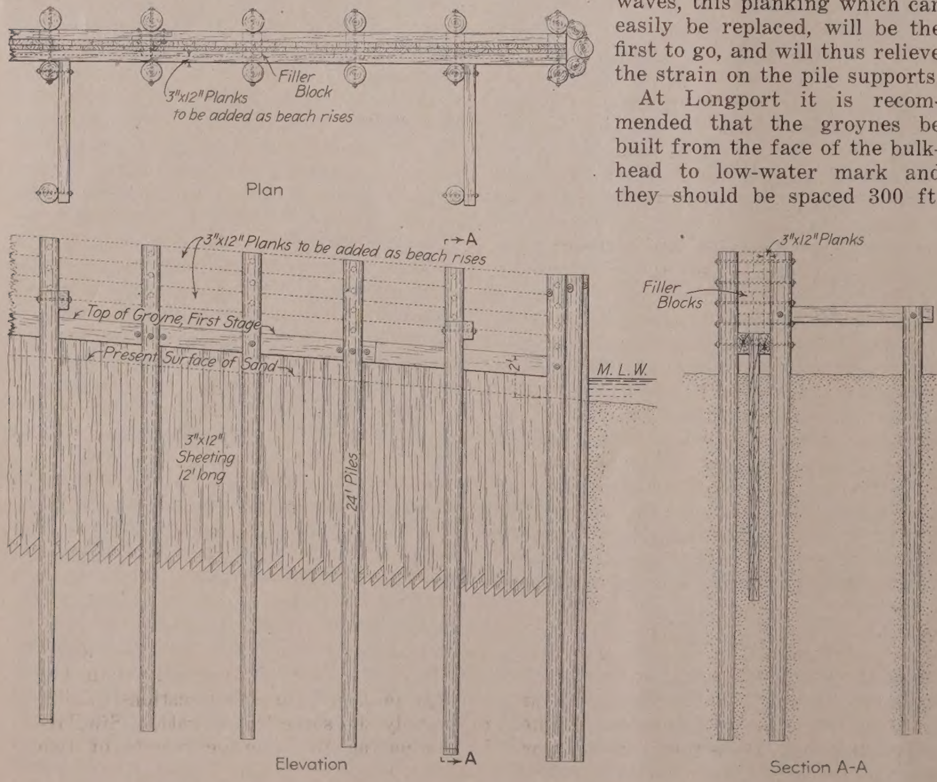
occur, sheet piling will be found most useful in protecting the bulkheads.

Cross bulkheads are also to be placed every 24 ft. so that in case the bulkhead is breached at any point, the sand will be retained on the relieving platform, except in the particular section which is breached. Without these cross bulkheads the effect of a breach might be to wash out the sand over a considerable length of bulkhead and therefore endanger it.

Groynes

In addition to this form of bulkhead a timber groyne has been designed which it is believed, in conjunction with the bulkhead, will tend to build up a beach. This general type of bulkhead and groyne construction appears to be applicable to the conditions at both Longport and Stone Harbor. These groynes are designed to be built 2 ft. above the level of the beach as it now exists. Provision is made so that they may be added to as the beach rises, and the planks that are added, to increase the height of the groynes, are comparatively light, so that in the event of the beach being eroded to any appreciable extent during heavy storms this planking will be broken and destroyed before the pile supports; the purpose being that if anything is to be destroyed by the force of the waves, this planking which can easily be replaced, will be the first to go, and will thus relieve the strain on the pile supports.

At Longport it is recommended that the groynes be built from the face of the bulkhead to low-water mark and they should be spaced 300 ft. apart. At Stone Harbor, where there is a bar that is almost bare at low water a short distance outshore of low-water mark, it is recommended that the groynes be extended out to this bar, which will probably then be brought inshore.



DETAILS OF GROYNE—NOTE PROVISION FOR BUILDING UP AS BEACH RISES

Precautions

It is inadvisable to construct a boardwalk outshore of the bulkhead. This at best is a light structure and is easily carried away, and the materials composing it act as battering rams to aid in the destruction of the bulkheads. The platform behind the bulkhead adapts itself very well as a boardwalk.

It will be necessary to protect the ends of these bulkheads by building return bulkheads sufficiently inshore so that the water may not get behind the bulkhead at their ends.

It will probably be desirable to use creosoted timber in certain parts of the bulkheads; this, of course, will increase the cost of construction, but owing to the activity of the teredo in these waters, creosoted timbering, where it will be exposed to the attack of the teredo, will probably be found economical in the long run.

These bulkheads and groynes have been designed with a view to reduce to a minimum the annual maintenance charges, and it is believed that if the structures are built in accordance with the plans and recommendations they will last for many years without any considerable cost for maintenance. Should any waling or plank on the bulkhead become damaged, however, it should be promptly repaired; a tight structure is necessary in order to retain the sand, and the replacing from time to time of an injured plank or waling may result in the saving of the structure which might otherwise be seriously damaged by the loss of sand through a break in the face.

Panama Slides Have Made Operating Costs Exceed Receipts

TOLL EARNINGS of the Panama Canal for its first eight months of operation, from July 1, 1914, to March 1, 1915, fell short by $261,098.09, or nearly 10 per cent, of expenses due to operation and maintenance, according to figures presented by the "Canal Record." These expenses were $2,595,613.33, while the toll receipts were only $2,334,515.24. Of the expenses, however, $1,012,695.39 is attributed to the removal of such slides as have occurred since July 1, 1914. This does not cover the work at the Cucaracha slide, which has been charged to operation, as the channel was not clear at the time of opening the canal for traffic.

For the month of March the tolls were $560,784.96, while the operating and maintenance costs, not yet summarized, are estimated at $425,000. Thus the loss is reduced to about $125,000, or 4 per cent, for the first nine months.

Horse-Drawn Vehicles on Chicago's principal downtown streets have decreased approximately 20 per cent since 1907, while motor vehicles have increased 600 per cent in a similar period. The total number of vehicles of all kinds has increased 11 per cent. These figures were compiled from traffic censuses taken each year by the Chicago Citizens' Street Cleaning Bureau.

Results of Recent Tests of Steel Columns Presented and Discussed

Early Permanent Set and Effects of Varying Area and Form Indicated by Experiments Conducted at Bureau of Standards

ALTHOUGH the results for only a relatively small number of the elaborate series of tests of steel columns now being conducted at the Bureau of Standards in Washington for the American Railway Engineering Association and the American Society of Civil Engineers are available, certain definite tendencies indicated by these results should be given general consideration. Similar sections of a given series show relatively small variations for changes in area, but when a large change is made in the make-up of the section, and hence in the radius of gyration, although the length ratio be kept the same, a striking decrease in strength for larger areas is obtained. The following discussion of data published in the American Railway Engineering Association's Bulletin 173, and in the progress report of the committee of the American Society of Civil Engineers presented at the annual meeting in January gives details of some of the results of these tests. This discussion embraces also the results obtained for one large column tested for the New York Central Railroad, and reported in the above-mentioned Bulletin 173.

GENERAL PROGRAM AND SPECIFICATIONS

Two complete series of tests, each consisting of 144 columns, are being conducted simultaneously for the committee on iron and steel structures of the American Railway Engineering Association and the committee on steel columns and struts of the American Society of Civil Engineers. These committees have worked in close collaboration. The U. S. Government is furnishing these columns, also eighteen columns of Bethlehem and eighteen columns of Carnegie H-section, and is conducting the tests at the Bureau of Standards in Washington, using the 2,300,000-lb. Emery testing machine.

The types of sections, sizes, radii of gyration, etc., used in these series are fully described in the sources referred to, although the sectional areas for the future tests in the railway association series are not given. All of the columns of the series for the American Society have been fabricated, and more than half tested, while only eighteen of the other series have been fabricated and tested. These two series are each composed of eight types of section; for each type eighteen columns are tested, three exactly alike for each of three different length ratios (50, 85 and 120) and two sections for each, a light and a heavy section. The variation in length ratio is obtained by keeping the make-up of the section constant and changing the length. The radii of gyration of these columns varies from 2¼ in. to nearly 3 in.

The A. R. E. A. specifications were used, supplemented, however, by rigid requirements of the committee of the American Society requiring gilt-edged workmanship, absolutely true dimensions, perfect straightness, exact punching, reaming after being assembled, facing of ends at exact right angles, and rigid limits in chemical composition. The desired ultimate strength for test specimens was 60,000 and the yield point was 38,000. The fabrication of the eighteen columns for the railway association was not altogether up to this especially high standard, but represents first-class shop practice. It was found that the heads and bases had to be scraped, and that the channels were not in complete bearing on the base plates, but closed into full contact at the application of loads of from 1000 to 5000 lb. per square inch.

METHOD OF CONDUCTING TESTS

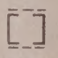
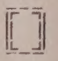
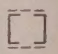
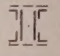
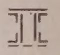
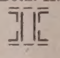
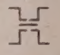
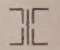
The tests were conducted by beginning at an initial load of 1000 lb. per square inch and making successive application and removal of load up to unit stresses of 5000, 10,000, 15,000, 20,000 and 25,000 lb. Complete and elaborate strain measurements for local deformations were taken, and above 15,000 lb. per square inch at unit-stress intervals of 1000 lb. For one column reported by the committee of the American Society the effect of time at high unit stresses was noted by repeating the strain measurements at the same load after varying intervals up to 70 min. Above the 25,000-lb. unit stress definite "flow" of metal was obtained, and at 27,000 lb. an increase in strain which would correspond to a unit stress of about 740 lb. was noted for the 70-min. interval. This column failed at a unit stress of 28,700 lb.

Strain-gage measurements along the length of the column are made at the center and near both ends, and in each case at the four corners and at the center of the webs and flanges. Deflection observations were made for both directions at the center of the column. First evidences of scaling and lines of scale were carefully noted. The exact cross-sectional areas of the columns are determined by weighing, deducting rivet heads and using the specific gravity. It was found that in some cases the variation between the actual and the nominal section used in designing was as high as 4 per cent, though generally within 1 to 3 per cent.

RESULTS OF TESTS

The accompanying table gives the values for approximate average elastic limit and for average ultimate strength, so far as these are available, and the areas and types of columns tested. There are included in this table, for comparison, the results of previous tests of steel columns as given in the progress report of the American Society committee in Vol. 66 of the Transactions, the allowable unit stress by the A. R. E. A. specifications and the corresponding factors of safety. One typical average stress-strain diagram is also shown as plotted by A. W. Carpenter, assistant valuation engineer and formerly engineer of structures of the New York Central Railroad, for the large-size column tested for that road and reported in the A. R. E. A. Bulletin. Only three other such diagrams for these tests are available, and in general they show similar characteristics. The results of the tests on specimens from component material used in the New York Central column show an average yield point of 38,100 and ultimate strength of 59,400 lb. per square inch, therefore the lower ultimate strength for this large column cannot be due to low strength of the component material, though it may possibly be due to workmanship. This column, of about 65-sq. in. section, gave a lower strength by about 23 per cent than the average obtained for small sections having practically the same length ratio. Similarly, comparing the average results of two series of columns for l/r of 120, it is found that one set gave about 11 per cent less

AVERAGE RESULTS OF TESTS ON STEEL COLUMNS

Length ratio	Average area, sq. in.	Type of section	Number tested	Series	Elastic limit	Ultimate strength	Allowable by A.R.E.A. spec., lb. per sq. in.	Factor of safety
50	9.32		3	A.R.E.A.	....	38,460	12,500	3.1
50	12.50		3		....	37,210		3.0
52	64.92		1	N.Y.C.R.R.	22,000	30,760	12,360	2.5
85	9.38		3	A.R.E.A.	....	34,000	10,050	3.4
85	12.00		3		25,000*	34,330		3.4
120	9.47		3		26,000*	33,000	7,600	4.3
120	12.34		3		25,000*	30,800		4.0
120	10.65		2	A.S.C.E.	23,000	28,640		3.8
Older Tests Reported in A.S.C.E. Transactions, Vol. 66								
45	15.80		1	C. P. Buchanan	19,000	31,680	13,250	2.4
46	29.36		1		25,500	30,640	13,180	2.3
50	7.33	Beth. H.	3	Watertown Arsenal	27,000	28,870	12,500	2.3
75	7.30	Beth. H.	3		27,300	28,880	10,750	2.7
81	17.44		2	J. A. L. Waddell	21,300	30,530	10,330	3.0
83	14.90		2	C. P. Buchanan	....	33,390	10,190	3.3
97	14.20		1		12,600	27,800	9,210	3.0
100	7.27	Beth. H.	3	Watertown Arsenal	....	27,300	9,000	3.0
125	7.27	Beth. H.	3		....	26,000	7,250	3.6
150	7.30	Beth. H.	3		....	23,560	5,500	4.3

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*For one only.

than the other, although the areas were about the same, and only the form of section was variable.

Apparently greater precision in measurement of strains seems to indicate permanent sets at unit stresses between 5000 and 10,000 lb. It should be noted in this connection, however, that these small sets would be explained if there should be an uncompensated difference in temperature of 1 or 2 deg. Fahr. between the column and the 150-in. measuring bar. The repeated-increment method of applying the loads in these tests makes it practically difficult to fix an elastic limit and almost impossible to note any yield point, and shows a definite tendency toward more nearly elastic variation for the later applications of load.

Variations in Local Strains

The strains measured at various points of the cross-section and at different positions along the length of the column give values fairly consistent with the average unit stress, although at higher intensities (say, about 15,000 lb. per square inch) they become variable across the section, showing the effect of ending stress. At the unit stress mentioned, these differences in local strains correspond to unit stresses of about 2000 or 3000 lb. and they increase to as much as 6000 or 8000 lb. per square inch for fibers at opposite corners of the section at unit stresses of about 25,000. Erratic and anomalous results were obtained for lattice bar stresses, which were generally found to be rather low.

In comparing the values for large and small sections of the same type it is found that the larger and more stocky sections give lower ultimate strength for two cases by 3 per cent and 7 per cent. No extensive study of the varying results of the strain measurements has yet been made for publication except by A. W. Carpenter for the single large New York Central column. In many respects, however, his conclusions seem to agree with the small amount of complete data available for the more important series, and are therefore abstracted as follows:

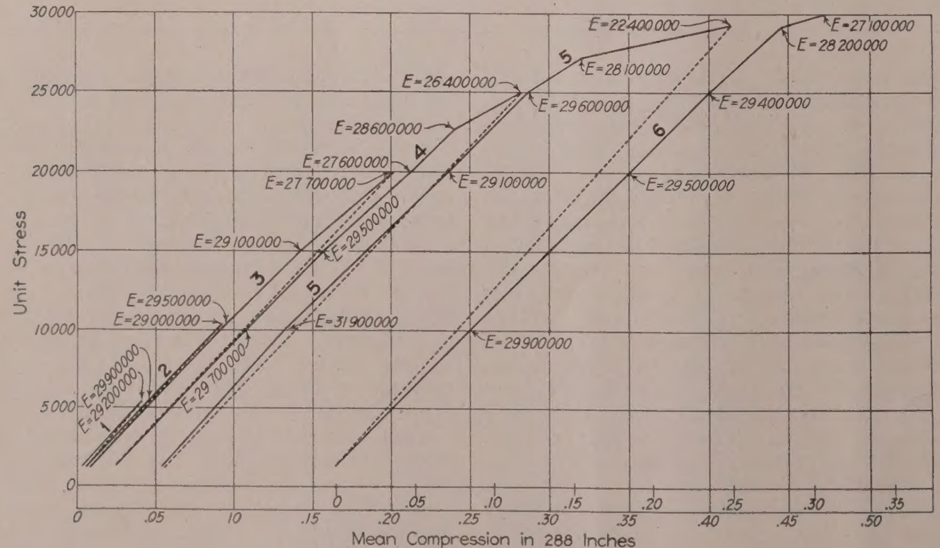
Permanent sets occurred at the loading of 5000 lb. per square inch, although no very appreciable set was found even at 10,000 lb. per square inch. The limit of true elasticity is raised by the successive loadings, the diagram for the last loading showing a practically straight line and practically constant modulus of elasticity up to 25,000 lb. per square inch, but at the expense of a considerable permanent set. In testing the remaining columns it is thought that it would be advisable to have the loads of various intensities repeated, without increasing, to see if there is an accumulative permanent set.

Stresses Corresponding to Local and Lattice-Bar Strains

It appears that the stresses in the column corresponding to the 10-in. gage measurement (using E = 29,500,000) are almost all higher than the average load on the column. It is notable that the maximum 10-in. compressions occurred in the vicinity of one or both of the diaphragms at about the third points, whereas it would seem natural to look for the maximum at the center of the column. The gage measurements in the lattice bars are very erratic, some of the greatest changes taking place at the smallest loads. The greatest recorded change is for a loading of 9000 lb. per square inch, and corresponds to 6500 lb. unit stress. It is noteworthy that the adjacent bars both carry compressive stresses in most cases, and that it is rather exceptional where one bar shows compression and the adjacent one tension.

Practically all of the columns reported appear to have failed as a whole and not locally, and were evidently designed properly to develop the full strength of the sections.

Credit for the thorough and scientific manner of conducting these tests should be given to Dr. G. R. Olshausen, engineer-physicist in charge, and to Dr. S. W. Stratton, director, of the Bureau of Standards at Washington. W. H. Moore is chairman of the sub-committee of the American Railway Engineering Association, and Austin Lord Bowman is chairman of the committee of the American Society of Civil Engineers. The test of the New York Central column, which is one of a small series being carried out under the direction of A. W. Carpenter, is reported through the courtesy of George W. Kittredge, chief engineer of the New York Central Railroad for the lines east of Buffalo.

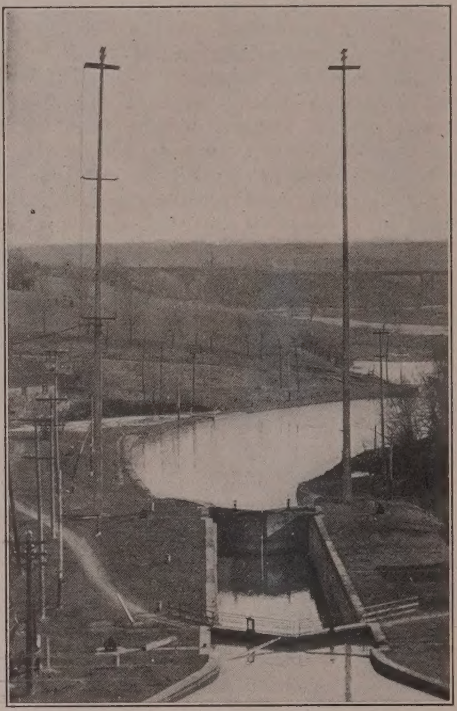


TYPICAL STRESS-STRAIN DIAGRAM FOR LARGE BUILT-UP COLUMN

As plotted by A. W. Carpenter. Computed values of coefficient of elasticity, E, are based upon average unit strain in 288 in., after subtracting initial value of permanent set

Tall Concrete Poles Have Given Nine Years' Service

TWO reinforced-concrete poles, each 150 ft. high, shown in the accompanying photograph, have been in service over the old Welland Canal at St. Catharines, Ont., for 9 years. Canal rules required a standard clearance of 150 ft. When examined recently by a representative of this journal they were found, so far as could be seen from the ground, to be in excellent condition, showing no sign of distress. They were designed for a horizontal pull at the top of 2000 lb., and the steel was considered at this pull to be stressed to its highest permissible limit, 30,000 lb. per square inch. The reinforcement at the bottom consists of four 2½-in. round rods—pins they might more properly be called were their length less. These are decreased in diameter as the stress decreases, the diameter at the top being ¾ in. The concrete is a 1:5 mix, using gravel. Turnbuckles are used to join adjacent lengths, the ends of which are upset. Each pole weighs approximately 40 tons, and was erected with timber shear legs, 96 ft. high, hitches being taken at three points, and the poles were hoisted in a manner similar to the gaff in a sailing vessel. The poles were cast by the Concrete Pole Company, Ltd., of St. Catharines, and were designed by and erected under the supervision of J. L. Weller, now engineer-in-charge of the Welland Ship Canal, who patented these poles.



CONCRETE POLES 150 FEET HIGH

Time-Consuming Chemical Determinations have been cut to a minimum at the purification plant at Columbus, Ohio. It is the belief of the officials that only such tests as give assurance of the purity of the water and assist in properly treating the water should be made a part of the routine schedule. Such tests as nitrogen, free and albuminoid ammonia, nitrates and nitrites and the determination of dissolved oxygen, oxygen consumed, and complete mineral analysis serve to advantage only in special cases.

General Practice in Sand Testing

Outfit and Methods Used in Denver Laboratory—Requirements for Acceptance by Board of Water Supply of New York

THE two articles which follow, though not closely related in the manner of treatment of the subject, are concerned with the practice in testing sand for use in concrete construction in two large cities. The first article describes the inexpensive apparatus used and the details of methods of testing sand as devised for the engineering department of the city of Denver about two years ago. The second article discusses the test requirements for acceptance of sand used by the Board of Water Supply of New York, and concludes with a series of condensed statements of the results of laboratory experience in making more than 1500 tests of various sands.—EDITOR.

Sand Testing at Denver

By E. B. VAN DE GREYN
Consulting Engineer, Houston, Texas

DURING the fall of 1912 the writer, while in employ of the city of Denver, established for the engineering department a cement and sand testing laboratory. Due to shortage of funds and because the testing had to be started on short notice, the laboratory was equipped with inexpensive apparatus that could be purchased from the supply houses in Denver.

Any engineer already possessing a cement-testing outfit should be able to equip for sand testing with light expense. In addition to the apparatus used in cement testing, the following is required:

One sand sieve No. 4; one each of Nos. 10, 20, 30, 40, 50 and 100, each with cover and bottom; six glass jars with rubber stoppers; three 500-cu. cm and three 100-cu. cm conical graduates (it is possible to do with fewer of these); one 500-cu. cm cylindrical graduate; twelve metal molds for 2-in. mortar cubes; one glass plate 15 x 15 x ¼ in.; one Bunsen burner; one standard; one water bath; dishes for drying and heating, and a quantity of standard Ottawa sand.

DETAILS OF TESTS

In the tests described all sands were first screened on the No. 4 sieve to remove large particles. The tests were then conducted as follows:

1. *Determination of Amount of Dirt and Organic Matter in Sand.*—(a) Where a determination of the amount of dirt and organic matter together was required, the sand was freed of moisture by spreading in a thin layer in sunlight and leaving until dry, or by means of a steam bath. The sample of sand was then weighed and washed thoroughly with successive washings, care being taken to give the fine sand a short time to settle before pouring off the dirty wash water. The sand was then dried thoroughly and weighed again, and the difference in weight gave the weight of dirt and organic matter.

(b) Where the dirt and organic matter were to be determined separately, the sample was freed of moisture as described above and weighed. The sand was then heated so as to drive off the organic matter and weighed. The sample was washed thoroughly as before, after which it was dried and the weight obtained. The amounts of organic matter and of dirt were then determined.

The method of determining the dirt and organic matter by evaporating the wash water and weighing the residue and then weighing again after heating the residue to drive off the organic matter was tried, but was replaced in most cases by the method described above. There were removed from the sand sample before testing any small pieces of wood or leaves which would not affect the strength of mortar or concrete.

2. *Gradation of Sand.*—The sample of sand was freed of its moisture as described in test 1, and the weight of dry sand determined, after which the sand was put in the nest of sand sieves, starting with the 10-mesh. The weight of sand retained on each sieve and that passing the 100-mesh sieve were secured and the total weight was checked against the original total weight. This gave data for plotting a curve showing the percentage of sand passing each screen and made it possible to determine the uniformity coefficient. It also showed whether there was an excessive amount of fine material in the sand. (If the sand is reasonably dry it is not necessary to dry it as mentioned above. The only reason for drying at all being to make the screening easier.)

3. *Voids in Sand.*—A definite amount of water was measured in one of the conical graduates, usually 100 cu. cm. Sand and water were put alternately into the 500-cu. cm cylindrical graduates in small quantities so that the sand voids were filled as the sand was placed in the cylinder. In this way air pockets were avoided. The sand was dropped into the cylinder, but did not pass through the water, thus avoiding stratification. As it was dropped into the glass it was allowed to slide down the side to avoid packing. When 100 or 200 cu. cm of sand were in place just enough additional water was poured in to bring the water level with the top of the sand. The reading at the top of the sand gave the volume of loose sand. The amount of water left in the conical graduate subtracted from the original reading indicated how much water was used to fill the voids in the sand. The percentages of voids in the loose sand was then easily calculated. The graduate containing the sand was then jarred until the sand would settle no further, leaving free water above the sand. Additional sand was dropped into the cylinder and the jarring was continued until enough sand had been added to bring the water and sand again to the same level, after which the surface of the sand and water was read again, giving the data necessary to determine the voids in the packed sand.

4. *Compression Tests.*—Two-inch cubes were made and crushed at 14 and 28 days in the compression machine at the School of Mines, Golden, Colo. Mortar of 1:3 mix was used throughout. Not less than three cubes for each age were made for each sample of sand tested. The sand was screened over a No. 4 sieve to remove coarse particles. A number of cubes were made with standard Ottawa sand in order to compare with them the crushing strength of cubes made of the samples of sand to be tested.

The amount of water used with each sand tested was that necessary to make the mortar in each case as nearly as possible of the same plasticity as the Ottawa sand samples. The sand tested was not dried but contained natural moisture so as not to remove any dirt coating the grains, which might affect the strength of the mortar. The same cement was used for all sands and for the Ottawa sand mortar briquettes.

5. *Tensile Tests.*—Mortar briquettes for the tensile tests were made in the same numbers and in the same manner as for the compression tests, and were broken in 7 and 28 days. In making these tests a test was made on each sand screened over a No. 10 sieve, all other conditions being the same as for sands passed over the No. 4 sieve. In all cases it was found that the sand screened on the No. 10 sieve showed less strength than the same sand screened through a No. 4 sieve.

6. *Microscopic Tests.*—The natural sand was examined under a microscope and note made of the shape of the sand grains, whether the grains were coated with impurities or were clean, the character of the grains, and the presence of foreign matter such as mica, wood or the like.

The writer believes that on any job where it is worth while testing the cement it is also worth while testing the sand. For those who do not care to make all of the tests, because of the amount of equipment needed or because the job would not warrant the purchase of complete equipment, tests 1 and 2 and probably 3 would be of great value in judging the sand, 1 and 2 generally being more important than 3.

Sand Testing at New York

By CHARLES M. MONTGOMERY
Inspector in Charge of Physical Tests, Laboratory of Board of Water Supply, New York City

SAND submitted for test in the laboratory of the Board of Water Supply is subjected to the following tests:

A sufficient quantity is dried and a mechanical analysis made of all material passing a No. 4 sieve. If any appreciable quantity is retained on this sieve it is noted and recorded as coarse aggregate. Fine aggregate is accepted if not more than 75 per cent passes the No. 16 and not more than 50 per cent the No. 50 sieve.

A determination of the weight is made either by the use of a box having a capacity of 1 cu. ft. and a Fairbanks scale having a beam graduated to 0.01 lb., or a graduate of 1000 cu. cm capacity and a balance weighing to 1 gram. The weight per cubic foot by the first method is of course direct. By the second method 62.4 W is the weight per cubic foot, W being the weight of sand in kilograms. In each case the determination is made on loose measurement, the sand being neither tamped nor shaken. Either method may be used with safety, as they check within 0.5 lb.

Specific gravity is determined by the Jackson apparatus, two determinations being made for a check. Results of these determinations must check with 0.02 or the determinations are repeated until they do check.

The percentage of voids may be readily calculated from the weight per cubic foot

W and the specific gravity S. Voids in per cent of total volume =

$$100\ (62.4\ S-W)/62.4\ S$$

Compressive mortar tests are made with each sand, six at 28 days and six at 3 months, 2-in. cubes of 1:3 mix being used. If the 28-day test gives 1000 lb. the sand may be accepted. If it falls below 700 lb. it is rejected. If it falls between the above values the material is held to await the result of the 3-month test, and if the result does not fall below 1300 lb. the aggregate is accepted.

In making compressive mortar tests the proportions used are 1:3 for a sand having a specific gravity of 2.67. When the sand is of a different specific gravity, say, 2.70, the proportion of sand is determined by the equation $3/x = 2.67/2.70$, the result being the absolute volume corrected to a specific gravity of 2.67.

Many density tests have been made, but when the apparatus is available for making compressive tests density tests are unnecessary.

GENERAL NOTES ON SANDS

The following are some notes on sand gathered from our laboratory experience, covering more than 1500 tests:

The mineralogical character is unimportant so long as the grains are hard. The black sands of the Hudson River valley are less "shaly" than they look. The grains are chiefly from the sandy, hard strata of the sandstone and shales.

The grading of sands is very important. Very fine sands may be used, but it is necessary to use an excess of cement. Sands having grains laminated by cleavage or mica planes give low-strength mortar, particularly in compression.

Artificial sands as ordinarily crushed give high strength tests. This is due chiefly to their coarseness and favorable grading. Used alone, they give harsh, rough concrete, lacking sufficient plasticity to work well in filling forms.

Mixtures of natural and artificial sands work well. Half-and-half mixtures are usually sufficiently plastic in concrete and give higher strength than the natural sands alone.

Many sands which look dirty contain nothing objectionable in any considerable quantity. This can be seen by the examination of a sample under a strong lens. The "dirt" is frequently seen to consist of clean, hard particles.

Fine sands make a larger volume of mortar than coarse. More water is required in the mixing. Some fine sands are favorably graded and give good results in strength. Fine sands favor imperviousness in mortar and concrete. Natural sands of which about 70 per cent pass the No. 16, 30 per cent the No. 50, 6 per cent the No. 100, and 2 per cent the No. 200 sieves, give impermeable mortar in proportions as lean as 1:3 under 40 lb. pressure. Other analyses differing much from the above give good results, even in proportions 1:4 or 1:5, but sands so graded seldom exist in nature.

Where screenings and very coarse sand are used, the roughness and low density of the concrete may usually be overcome by using a larger proportion of the sand or screenings, and reducing the coarse aggregate correspondingly.

Experimental Mississippi River Levees Indicate Possibility of Eliminating Seepage

Embankments Faced with Concrete and Provided with Sheet Piling at Toe Stop Flood Waters That Penetrate Larger Dikes of Standard Design

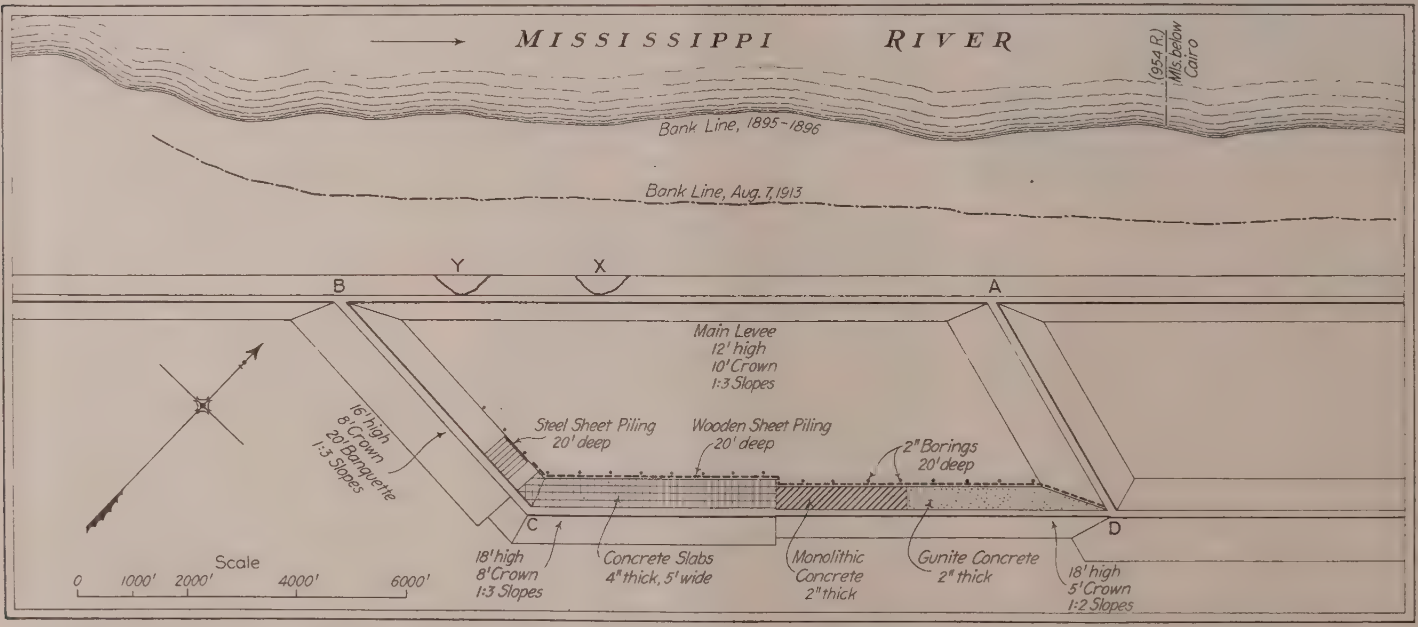
By MAJOR C. O. SHERRILL
Corps of Engineers, U. S. Army

FOLLOWING the excessive seepage that occurred through the standard Mississippi River levees during the great floods of 1912 and 1913, experimental work was undertaken with a view to determining whether a smaller section levee protected with gunite over its face and with interlocking sheet piling extending 8 or 10 ft. deep at the foot of the levee would not decrease the percolation of water through the levee so as to keep it dry for the average period of highest flood namely, from 30 to 40 days. The writer undertook these experiments with the idea that the protection of levees in this way would add largely to the friction of the water flowing through the levee, due to the necessity of its passing over the longer path around the bottom of the sheet piling and upward toward the surface against gravity and frictional resistance of the soil; and that for the period during which levees are subjected to the pressure of flood water this increased resistance to percolation would probably delay the rise of the seepage plane sufficiently to allow the levee to remain dry until the danger was passed. It has been thoroughly demonstrated, moreover, that a dry levee of any size practicable to build is a safe levee, and that any thoroughly saturated levee, no matter how large its section, is useless as a means of protection.

EXPERIMENTAL LEVEE SECTIONS

The proposed protection work has been completed as follows: A levee 1276 ft. long, running around two sides of a basin as shown in the plan, was built in the rear of the main line to form a basin in which water could be impounded. The upper wing is full standard section with banquette and no additional protection; a length of 382 ft. is standard section without banquette, with slopes 1 on 3, and with 4-in. concrete and 20-ft. sheet-pile protection; the remainder has a 5-ft. crown and slopes of 1 on 2, with 2-in. gunite and 20-ft. wood interlocking sheet-pile protection. A length of 50 ft. has concrete and interlocking steel-pile protection, placed at the expense of the Lackawanna Steel Company to test its new 11-lb. steel interlocking piling. Except for this 50 ft. of steel piling, the remainder, 857 lin. ft., was of interlocking heart pine type, 5½ in. thick, driven 20 ft. deep.

This piling proved easy to drive, as there was no tendency for the piles to drift, either at top or bottom, due to the interlocking.



EXPERIMENTAL LEVEE SECTIONS WERE BUILT AROUND TWO SIDES OF A BASIN WHICH WAS AFTERWARD PUMPED FULL

CONCRETE WAS PLACED IN SEVERAL WAYS ON FACE OF EAST LEVEE

Practically all of the piles were driven to full 20-ft. penetration with an average of twenty blows per double pile. A drop hammer weighing 2350 lb., with a fall of 12 ft., was used. There had been previously used by the Fourth District office various types of wood piles for levee protection, including Wakefield, dovetail, interlock, spline, crown, and tongue and groove, but none of these can compare with the standard interlocking type, patented by the Alexandria Lumber Co., Alexandria, La., as to ease of driving and water tightness.

CONCRETE FACING

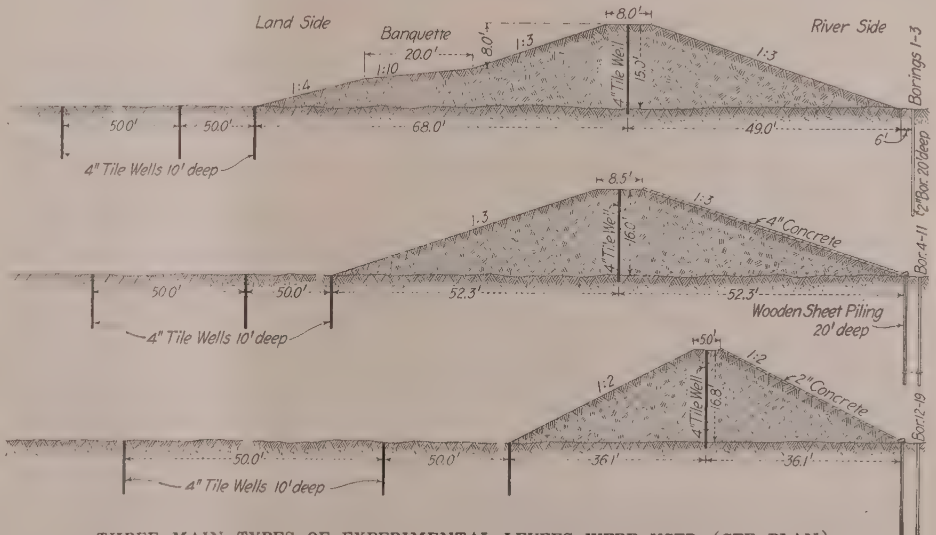
On the surface of protected portions was placed either ordinary concrete (1:3:5) 4 in. thick or "gunite" 2 in. thick. The gunite was placed on a levee of small section to give it as severe a test as possible in comparison with the ordinary concrete. The largest section levee, which is the standard Mississippi River Commission type, was left unprotected in order to have a direct comparison between this levee's efficiency and that of the smaller protected sections.

The gunite was placed on the levee in several different ways: (a) Directly on the levee itself, (b) on the levee with light reinforcement, (c) on gravel spread on the levee with reinforcement on the top, (d) on gravel with no reinforcement. In each case the top of the sheet piling was encased for one foot down with gunite reinforced by light wire mesh. The last method named, that is, gravel with no reinforcement, proving most satisfactory, was adopted for the bulk of the work. The gravel was spread 2 in. thick on the levee and was then treated with gunite to concrete it in place. This was found to give a dense concrete practically impervious to water, as was shown by a basin constructed by this office. This basin was hopper shaped, 4 ft. square at the top, 2 ft. square at the bottom and 2 ft. deep, and was constructed with a 2-in. layer of gravel treated with gunite. After this gunite had set, the basin was removed from its earth form, and being placed on timber supports and filled with water, was tested as to percolation, with the result that it was found to be practically water tight after a week's test. This mixture consisted of 1 part cement to 3 sand and 3 of gravel.

After experiments in placing the gunite by the various methods mentioned above had been made, it was found that the products secured by spreading a layer of 2-in. gravel ranging from ½ to 2 in. in diameter and treating with very wet gunite of 1 part cement and 1 part sand gave an impervious dense mixture 2 or 3 in. thick at a cost of about 33 1/3 per cent less than the ordinary 1:3:5 concrete mixture 4 in. thick.

LOCATING THE PLANE OF PERCOLATION

Four sets of test wells, with four wells in each set, were driven and lined with porous terra cotta pipe, in order to determine the rate and amount of rise of the plane of percolation of water through the levee under the head caused by the filled basin. On account of the saturation of the levee by heavy rains previous to the filling, it was found that water in the wells driven through the center of the levee rose about 12 ft. above the natural crown surface before any water was pumped into the basin.



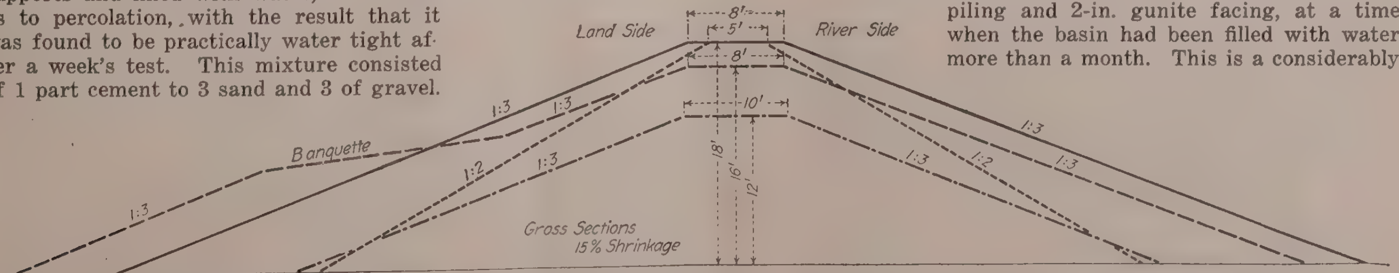
THREE MAIN TYPES OF EXPERIMENTAL LEVEES WERE USED (SEE PLAN)

The basin was pumped full of water up to 41.8 ft. Cairo datum, 0.6 ft. below the 1912 high water, between July 18 and 25, 1914. On July 27 a slough occurred 80 ft. long at its base which took out 3 ft. of the crown at the point marked X on the plan. It had been the intention to raise the water about 1½ ft. higher, but owing to this dangerous slough of the old main levee, which threatened to cause a crevasse toward the river, the pumping was discontinued. At this time, the land-side of the threatened main levee (A) was blanketed with earth and the entire length of this main levee from A to B was thoroughly drained on the river side to carry off the seepage as fast as possible, in order that a crevasse might not occur in this levee before the experimental sections D-C-B should have had a thorough test.

Aug. 5-6 the water was further raised to 0.4 ft. above the 1912 high water. Two days later a slough occurred at Y, taking out 4½ ft. of the crown, and but for prompt protective work a crevasse would have occurred on this date.

LITTLE SEEPAGE THROUGH EXPERIMENTAL LEVEE

The first seepage in the new experimental levee D-C-B began July 23, 1914, in the standard full-section unprotected levee near its junction with the main levee at B, and has continued increasing since. The second seepage began July 29 at the land-side toe of the levee at Sta. 3693 behind the concrete protected levee. The third seepage began Aug. 8 on the land-side slope opposite Sta. 3690 + 60, about 15 ft. up from the toe. The seepage at these two places covered small areas 6 or 8 feet in diameter and of small amount. No seepage whatever had occurred in the small-section levee itself or in the fields behind the small-section levee protected with interlocking sheet piling and 2-in. gunite facing, at a time when the basin had been filled with water more than a month. This is a considerably



OUTLINES AND GENERAL DIMENSIONS OF THREE ABOVE SECTIONS AND STANDARD LEVEE ALONG RIVER COMPARED longer period than the levees are usually subjected to the strain of the highest water of the Mississippi River floods, as the extreme height is reached gradually and the water at once begins to subside.

The behavior of the protected sections as compared with those unprotected indicates the superiority of protected levees of small section over the larger standard sections of earth alone. The old main levee, although of much less height and larger section than the protected portions, as shown in the drawing which compares the four sections, began to seep throughout its entire length shortly after the basin was filled and continued to grow worse from that time on. The new standard section also showed considerable seepage in its upper portion; the concrete protected levee seeped at only two small places. The smaller section gunite and sheet pile protected levee showed no seepage. The levee itself and the fields in the rear remained dry.

INTERLOCKING WOOD PILING THAT PROVED SATISFACTORY

REASONS FOR SEEPAGE

The two seepage areas behind the concrete protection can probably be explained by the fact that in driving the sheet piling two logs, buried from 10 to 15 ft., were struck by the piles, which were badly shattered and probably did not make a tight cut-off wall at those points. It is also possible that the seepage at these points was caused by cracking of the concrete, due to the excessive subsidence of the levee where extensive slides had previously occurred and had been replaced in the construction of the levee. In localities where levees are subjected to wave-wash or where the land on which to build the levee is expensive the protection is especially valuable.

Tables have been compiled showing that for heights of more than 16 ft. the smaller levee with gunite and interlocking wood sheet piling with 10-ft. penetration costs less than the standard large unprotected levee. For the heights up to 16 ft. the standard small levee costs more than the large unprotected one.

ONE MAN OPERATES the three Mueller water meter testing tables belonging to the Milwaukee waterworks.

Misleading Boring Records Are Grounds for Recovery of Damages by Contractors

Supreme Court Decides Case of Long Standing, Protecting Contractors Who Base Bids on Information Furnished by Engineer

WHEN the results of borings, made by the engineer prior to the receipt of bids on a contract, misrepresent the true character of the material encountered in excavations, a contractor is entitled to recover additional compensation for the extra expense incurred by him under conditions more difficult than those indicated by the drawings and specifications. This is the opinion of the United States Supreme Court as expressed by Justice McKenna on April 12 in the case of Christie, Lowe & Heyworth vs. The United States. The case had been pending in the Court of Claims and later in the Supreme Court for a number of years. It was argued by George A. King and Frank B. Fox, for the claimants, and by assistant attorney-general Thurston Thompson for the Government. The discussion of the case took a wide range, and involved an examination of decisions by a large number of American courts, both Federal and State, and by the courts of both England and Scotland. The purpose of borings as preliminary engineering work was, perhaps, most fully shown in a recent decision of the Scotch Court of Session, in which a railroad was held liable for misrepresentations made in the reports of borings.

DECEPTIVE INFORMATION CHARGED

The decision of the Supreme Court follows the same line of reasoning and, insofar as it relates to the misrepresentations of the boring sheets, is as follows:

"This item is based on a charge of erroneous and deceptive borings and misrepresentations in the specifications and drawings.

"By paragraph 48 of the specifications it is, among other things, provided: 'The material to be excavated, *as far as known* [italics are the Court's], is shown by borings, drawings of which may be seen at this office, but bidders must inform and satisfy themselves as to the nature of the material.' It is upon this paragraph the contention turns. The allegations of the petition of claimants are to the effect:

"That, invited by the provision, claimants examined the drawings and they 'showed gravel, sand and clay of various descriptions, and showed no other materials.'

"That the material actually to be excavated 'consisted largely of stumps below the surface of the earth, buried logs, of cemented sand and gravel (none of the sand or gravel being described in the said drawings as cemented), and of sandstone conglomerate,' and that such materials were far more difficult and expensive to penetrate and excavate than ordinary sand and gravel such as was described in the drawings.

"That the existence of the more difficult and expensive material was known to the persons who made the borings and to the resident engineer of the United States under whose supervision they were made; and that the statement in the specifications was untrue in fact and misleading, causing the claimants to propose to do the work upon the basis shown by the drawings and not upon the basis of the more difficult and expensive work, which in point of fact existed and was known to the officers of the United States. That claimants were forced to rely wholly upon the information furnished them, the time not being sufficient to permit them to make their own borings, and they believed the information furnished them to be accurate and reliable. That the erroneous and deceptive drawings misled claimants and they were compelled to spend $10,510.30 over and above the rates named in their proposal and contract, which rates were based upon the materials shown by such drawings.

"We think the findings substantially sustain the allegations. They establish that borings were made and that the drill met 'obstructions which from the particles broken off and floating to the surface would indicate they might be logs.' These obstructions, though in some instances noted because of the formation, were not indicated on the drawings.

BORING RECORDS OMIT LOGS

"And this was found: 'When such obstructions were met, the apparatus was moved elsewhere until a place was found where the drill would penetrate, and the result was recorded as if taken at the place staked out.' And further: 'The boring sheets referred to in paragraph 48 of the specifications contained only the record of completed borings and do not show any record of sunken logs, or of cemented sand and gravel, or conglomerate impenetrable by the drill.'

"The indications of buried logs were called to the attention of the resident engineer and he was asked if they should be noted in the record of borings, to which he replied that he did not consider them of enough importance to be noted. It was, however, found that the evidence did not establish to the satisfaction of the court that the statement of the engineer was other than an honest expression of his opinion, nor was it made to induce the omission from the records of the borings of any logs actually encountered, or for the purpose of concealing the same from or misleading subsequent bidders.

"It would seem as if there could be only one conclusion from these findings. There was a deceptive representation of the material, and it misled. In opposition to the seemingly irresistible conclusion that claimants were justified in their reliance upon the drawings, it is contended that the river was alluvial and its character warned claimants of the possible conditions which existed and that besides the court found 'they admitted they had reason to, and did expect to, encounter some logs.'

"The contentions are attempted to be supported by the alluvial character of the river, as we have said, its tortuosity, its fluctuations between high and low water in winter and summer, and that for twenty years the United States had operated snag boats for the removal of stumps and sunken logs from the channel of the river. But inferences from such facts could only be general and indefinite, and were not considered by the Government as superseding the necessity of special investigations and special report. It assumed both were necessary for its own purpose and subsequently would be to those whom it invited to deal with it. Knowledge of the result of such investigations would protect the Government, it might be, against an extravagant price based on conjecture of conditions, and enable contractors confidently to bid upon ascertained and assured data. And how important it was to know the conditions is established by the finding that claimants were put to an expense of $6,150.00 over what would have been necessary 'if the borings sheets had represented the character of the ground with respect to logs.'

"It makes no difference to the legal aspects of the case that the omissions from the records of the results of the borings did not have sinister purpose. There were representations made which were relied upon by claimants, and properly relied upon by them, as they were positive—Hollerbach vs. United States, 233 U. S. 155. Besides it was admitted at the argument that time did not permit borings to be made by claimants. We think it was error, therefore, to have disallowed the damage resulting therefrom."

After discussing other items of claim which were upon the facts found by the Court of Claims held to be not sufficiently established to warrant recovery, the opinion concludes as follows:

"For the error in not allowing the demand of the greater expense of excavation and pile driving, due to the misrepresentation of materials in the specifications and drawings, the judgment is reversed and case remanded for further proceedings in accordance with this opinion."

Fouling of Suction Lines at Small Water Stations Overcome

By J. T. BOWSER

Maintenance-of-Way Department, Queen & Crescent Route, Danville, Ky.

THE FOULING of suction lines, pumps and filters through accumulation of grass, leaves and other small trash or drift are troubles with which practically all railroad water-service men and others having to do with small water stations have had more or less experience. The following is a description of a device which has proved successful in overcoming trouble of this nature.

The stream from which this particular supply is obtained is comparatively shallow, and is subject to sudden freshets, which are always accompanied with large drifts of leaves, grass and sticks, from which a great deal of trouble was experienced. The suction line was, at such times, continually fouled, and, on account of the high water, considerable difficulty was experienced in keeping it clear. The bed of the stream consisted of boulders, gravel and sand, and even at times of extreme drought water could be found in ample quantities in excavations made in the bed outside the dry-season channel.

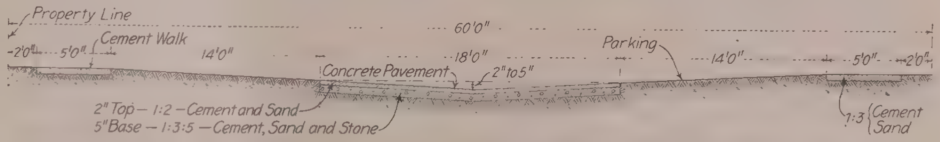
During the dry season an excavation was made in the bed at a point as close as possible to the permanent channel. This excavation was carried to a point of approximately the same depth as the bottom of the permanent channel. A crib of heavy second-hand timbers, securely bolted together, was constructed therein. This crib was roofed over with the same material and the whole structure was covered with large boulders to weight it down, though the top of the crib was carried only to the approximate level of the stream bed at this point. A line of pipe of about twice the diameter of the suction line was then laid downstream to the pumping sump, fall enough being given to insure a flow of water from the crib to the sump.

It was found that even in the dry season the supply which seeped into the crib through the gravel bed was ample for all purposes, and the water was much clearer than that in the permanent channel. In times of high water the structure is completely submerged and at this time, being entirely full of water, there is practically no suction around it, and consequently no trouble at all from trash and drift.

Concrete Pavements with Dished Surfaces

Substitution of Center for Side-Gutters Proves Satisfactory in Suburb of Cedar Rapids, Iowa, Where There Are No Curbs

CONCRETE pavements with a dished surface or inverted crown are a feature of Vernon Heights, a recently developed suburb of Cedar Rapids, Iowa. This type of design was used due to lack of curbing on many of the streets of the new district. The grade is dropped from side to center 2 to 5 in. depending on the amount of drainage.



CONCRETE ROADS WITH CENTERS DEPRESSED OBVIATE NEED FOR GUTTERS AND SEWERS

By building the road in this way it is asserted that the necessity of laying a town sewer at the present time is obviated. The accompanying design, prepared by F. A. Greene, engineer in charge of the work for the Anderson Land Company, shows the standard cross-section adopted. As the walks are placed 6 in. higher than the edge of the pavement, the whole street has a symmetrical appearance, and the surface water does not cut the parking. Mr. Greene is of the opinion that where country roads are built of concrete an inverted crown would be the best surface, doing away with the ever present washed-out gutters.

Approximately 12,000 sq. yd. of the inverted-crown pavement were laid last year, at a cost of $1 per sq. yd. The cost of material was as follows: Cement, $1.31 per barrel; sand, $1.35 per cu. yd.; stone, $1.52 per ton; mixer, $190 rental; forms, coal, oil and repairs, $261.18; insurance, $40. Labor costs were as follows: Grading, $537.08; forms, $132.43; concreting, $771.65; finishing, $173.66; joints, $46.75; water lines, $16.48; miscellaneous, $243.77; hard cement, $45.41. In all the material amounted to $4563.49 and the labor to $1967.23, making a total cost of $6530.72 for 6000 sq. yd. of pavement and 1152. cu. yd. of grading.

THE COMMON-CARRIER BACTERIAL STANDARDS of drinking water adopted by the U. S. Treasury Department are considered too high by the officials of the purification plant at Columbus, Ohio. In the 1914 annual report they state that the daily bacterial records at the Columbus plant indicate that positive presumptive tests in 10-cu. cm portions of the filtered supply do not always mean an unsafe water, for they sometimes occur when 1-cu. cm portions of the same sample do not contain any bacteria. Therefore the standard for the drinking water supplied to the public by common carriers in interstate commerce may work an injustice upon well regulated municipal water-purification plants, for undue suspicion is likely to be thrown upon the plant, and the minds of the citizens may become unduly prejudiced against their public water supply if it becomes known that the water has at some time failed to meet the Government requirements.

Use of Six-Inch and Eight-Inch Aggregate Points to Economies in Concrete Work

Is Cheaper Than Smaller Sizes and When Machine Mixed Produces a Stronger Concrete—No Difficulty Is Found in Handling Mixture

By EDWARD O. KEATOR, C. E.
Cincinnati; Formerly Superintendent of Construction of the Gatun Spillway

CHIEF among the important points in the making of concrete which have received but little attention is the advantage of using the largest possible sizes of aggregate. By using smaller sizes a great deal of money is thrown away every year. In many instances, principally in paving operations, concrete is now being laid which might just as well be 100 per cent better without costing a cent more, or might be just as good at a much less cost, simply by using larger aggregate. The mistake should be corrected at once, and this article is contributed to show how and where it has been accomplished. New principles will not be discussed here, and no credit is desired for stating the results discovered by well-known investigators in the concrete field. The writer has simply taken the results for what they are worth and used them in his work.

SIZE OF AGGREGATE AND STRENGTH

It is generally believed that large aggregate makes stronger concrete than small aggregate, other things equal. Anyone doubting this can enlighten himself by studying the investigations of Wm. B. Fuller and Sanford E. Thompson, published in the "Transactions" of the American Society of Civil Engineers, Vol. 59. First and foremost among the conclusions drawn from the results of several hundred experiments by these authors is that "stone of the largest size makes the strongest concrete." They also state that the best all round results with the least cement are obtained with a scientifically graded mixture, in which not less than 7 per cent of the cement and sand mixed will pass through a No. 200 sieve; about 38 per cent through a sieve, the meshes of which are one-tenth the diameter of the largest aggregate; and the remainder increasing uniformly in size up to the maximum. From this it will be seen that sand is a relative term; for example, in a concrete composed of aggregate graded down from a 6-in. maximum, everything under 0.6 in. would be sand. Usually the best results are obtained, with the least cement, when the largest grains of sand are slightly smaller than the smallest stone.

Scientifically graded mixtures are best, but they are seldom practical. The best results, however, are obtained by using those materials which nearest approximate the scientifically graded materials. This will perhaps explain to the reader the apparent inconsistency of the previous statement.

INFLUENCE OF SURFACE AREA

The larger the aggregate, the less surface area to be covered with cement. This means a saving of cement independent of the saving obtained by increased density as related to voids. Surfaces differ from voids in the manner in which they appropriate cement. Voids take the mortar just as it is mixed. Surfaces take the cement and only those grains of sand that are as small as the particles of cement. This is easily proved with the microscope and corroborated by strength tests, and is due to two forces, capillarity and skin friction.

At the age of six months ordinary 1:2:4 concrete has a compressive strength of about 2800 lb. per square inch. The 1:2 mortar into which the four parts of stone are dumped, has a compressive strength of 4800 lb. per square inch in six months. Thus the stone added to the mortar has robbed the mortar of an amount of cement which leaves it 2000 lb. per square inch weaker. Moreover, if the concrete is not well mixed, the stone surfaces get their cement only from the mortar in immediate contact with the stone; hence that mortar is weaker than mortar nearer the center of voids and rupture will occur first at the surface of the stone, a common point of failure. This proves the necessity for thorough mixing, a process lost sight of where "plums," "one-man" stone, cyclopean stone and the "batch-a-minute" slogan are used.

SURFACE AREA AND SIZE

Cement may well be compared to paint, since it acts the same way in covering surfaces. A given amount of paint will cover a house on the outside; more will be required to paint the rooms inside the house. Similarly, a large stone in concrete can be covered with a given amount of cement; broken into pieces the stone will require more cement. When it is noted that the strength of mortar in 1:2:4 concrete has dropped from 4800 lb. per square inch to 2800 lb. per square inch, the importance of conserving the cement in the mortar becomes apparent. The first step is to use the largest aggregate possible; this results in less surface area whether the voids remain the same or are decreased. Since the amount of surface area of a round or square body varies directly as the square of the diameter or of the side, aggregate graded down from 6 in. has but one-third the surface area of an equal amount of aggregate graded down from 2 in. From this it is to be seen that here is an important factor making for strong concrete, and it is reasonable to assume, that with reduction of two-thirds in the surface area where 6 in. maximum aggregate is used in place of 2-in. aggregate, the lost strength of 2000 lb. per square inch would be reduced proportionately. This would mean then that 1:2:4 concrete using 6-in. maximum aggregate would at six months have a strength of about 4100 lb. per square inch.

Experiments prove the larger the aggregate the denser the concrete. Here follows another saving of cement, because with specified proportions of cement, sand and stone, it is assumed that the concrete produced can be manipulated. It would be expensive folly to increase the amount of mortar in a concrete that already has sufficient.

Using an aggregate graded down from 6 in. increases the density about 12 per cent with ordinary medium sand and bank-run gravel. In such a mixture there would be 12 per cent surplus mortar, an inexcusable waste. Twelve per cent of surplus mortar contains 24 per cent of all the sand used. If now in a 1:2:4 concrete with ordinary aggregate, sufficient mortar is present and it is intended to use, in place of this concrete, one with the aggregate graded down from 6 in., a part of the mortar can be eliminated in a manner which will actually increase the strength. Since this mortar contains 24 per cent of the sand put into the concrete, eliminating this amount but with no elimination of cement, leaves 1:1½ mortar instead of a 1:2 mortar; increasing the strength from 4800 lb. per square inch to 5600 lb. per square inch. This enriched mortar will raise to a higher figure the 4100 lb. obtained through decreased surface areas.

VARIATION IN STRENGTH

Foremost authorities agree that a certain amount of pounding, rubbing and grinding in the mixer is highly beneficial to the production of the strongest concrete for any proportions of ingredients. This is most thoroughly done in a given length of time with the largest size aggregate, and it is an element to be taken into consideration where the strongest possible concrete is desired—another argument in favor of the use of the largest possible aggregate.

Having reviewed the points relating to the importance of large aggregate, it can be stated that from an inspection of tables of strength of mortars and concretes, made from different sized aggregates, an approximately constant relation exists between the strength and size of aggregate, in which the strength seems to vary as the cube of the maximum size and holds for mixtures of 1/100 in. maximum size up to 2¼ in. maximum size aggregates. Tests of materials larger than 2¼ in. in size are not available, but as pointed out before, it is reasonable to assume that the relation continues or can be made to continue by reducing the sand and retaining the same amount of cement, etc., at least up to a size impossible to handle without machinery. It is a serious mistake not to take advantage of the strength gained by using large aggregate to the limit of practicability. Obviously this applies particularly to concrete used to resist abrasion, as in concrete road work.

Applying these principles to the construction of concrete pavements, the proper course to follow is very plain. Since good limestone has a compressive strength of 10,000 lb. per square inch, a figure way above the strength of any mortar, it is evident that the best wearing surface is one in which the maximum surface of the stone is exposed to the traffic, bound together by the strongest mortar obtainable.

LARGE AGGREGATE IN PAVEMENTS

There are engineers who argue that one large stone, the diameter of which is the same as the thickness of the pavement, would cause a weak spot in the pavement. The writer is unable to see this, taking the opposite view. In noting the effect of a blow, the supposedly weakest spot in the concrete is first considered. With a first-class limestone aggregate, the property of adhesion at the surface of contact between stone and mortar would first be noted. A blow produces less effect on a large stone than on a small stone, because the large stone, being heavier, absorbs a larger proportion of the blow and, having a larger surface, distributes the blow over a larger area, affecting adhesion less. Then, too, the fact alone of having used the large stone has produced a richer mortar with greater adhesive strength. The writer might add that while giving no thought to these reasons at the time, he has broken up plenty of concrete with sledge and bull-point and knows full well that the very spot to avoid is the big stone. That is removable only after the concrete has broken away from it.

Now as to the cost of the larger material: Quarry-men say the cost of crushing rock varies inversely as the size. To use the largest aggregate possible would, in most instances, mean a saving in the cost of the stone of from 10 to 50 cents per cubic yard. It might even mean the total elimination of crushers in many gravel banks. Larger material costs less than smaller material and the amount saved more than offsets the extra cost of handling from the ground into wheelbarrows at the mixer. This applies to crushed stone only and not to gravel where size makes little difference.

What is the limit of practicability? For an 8-in. pavement, the writer advocates a maximum aggregate of 6-in. crushed stone or 7-in. gravel; and bases this statement on actual experience with large aggregate on similar work. In this matter as in no other pertaining to concrete, is such ignorance and prejudice shown even by the efficiency engineer. The writer has asked many engineers, contractors, architects, and foremen what they know about concrete made from an aggregate approximating 6 in. in maximum size. Almost to a man they argue against it, although they admit they have never used nor have seen used, aggregate of that size. By "used" is meant, run through the mixer and placed as ordinary material. Is it not ignorance and prejudice which prevents a man from seeing and taking advantage of the possibility of a gain of 100 per cent in efficiency?

EIGHT-INCH AGGREGATE IN GATUN SPILLWAY

At Panama in 1909, when the stone crushers were first installed at Porto Bello to crush trap rock for the Gatun locks and spillway, an accident occurred which put the smaller crushers temporarily out of commission. These crushed the rock from 3 in. down and were fed from large crushers which reduced the stone to 8 in. and down. Col. William L. Sibert, division engineer, conceived the idea of experimenting with the 8-in. crusher-run material and had a barge load sent to the spillway plant, where it was to be unloaded, stored, mixed and placed the same as was usual with the 3-in. rock. The writer, who was in charge of the work, was instructed to observe the whole operation.

Unloading at the dock was done by a locomotive crane with a 3-cu. yd. Brownhoist clamshell bucket. Some difficulty was experienced with the 8-in. material because the jaws would not readily penetrate the mass of large rock, but there was no delay on that account. No trouble at all was experienced in charging and mixing.

HANDLING THE MIXTURE

The spillway channel floor is 285 ft. wide by 900 ft. long, of varying thickness. Placing at the time was going on at the extreme end where the thickness was but 18 in. on solid rock. At first there was some trouble because the men were not as careful as they should have been about placing the bucket in exactly the right spot before dumping. It was harder work to shovel the larger material than the smaller, but there was no difference in puddling. They soon learned where to dump the bucket to best advantage and there was no further difficulty. Since a single bucket contained 2 cu. yd., the necessity for placing the bucket in exactly the right spot may be readily seen. This concrete, in fact practically all the concrete in the spillway, was the ideal, smooth, mushy mixture, easy to puddle and push into place. The writer had buckets of concrete made of the 8-in. aggregate dumped and flattened out to a thickness of 10 in. without any trouble, just to see if it could be done, and reported that the 8-in. material could just as well be used as the 3-in.

The spillway floor was laid in blocks of 20 x 30 ft. A straight edge 22 ft. long, resting on the edges of the forms, was used all the time, and every batch levelled to it immediately after dumping. It must not be inferred that the concrete was levelled with the straight edge; it merely showed all the time, the exact height at which to leave the concrete. On the 18-in. floor, the idea was to dump just a trifle more than necessary and puddle it ahead as the work progressed, keeping it to the proper level by shaking, tamping, and smoothing with shovels. The mixture was proportioned 1:3:6 and an abundance of mortar was always present.

THE OPPOSITE EXTREME

As an example of the opposite extreme the the following case may be cited: In 1912 the writer was in charge of reinforced-concrete work where at the beginning three carloads of ½-in. roofing gravel were delivered instead of the 1½-in. gravel specified. It was decided to use this gravel. The specified proportions were 1:2:4 but with that small aggregate the concrete could not be manipulated until a whole sack of cement to the cubic yard was added. Even then the concrete was rough and it cost about $50 to point up that afternoon's work. The point is, that here was an actual case where the aggregate, ½-in. pea gravel, was too small.

THREE AND FIVE-INCH GRAVEL IN A REINFORCED-CONCRETE BUILDING

In 1913 the writer erected a reinforced-concrete building at Portsmouth, Ohio. It was of the flat-slab type of construction, using the C. A. P. Turner system of reinforcing. There were eight slabs, some of which were 6½ in. thick and some 7 in. The concrete specifications called for stone passing through a 1¼-in. screen. A material was available at $1 per cubic yard which contained too large a proportion of ¼ to ¾-in. sizes. Another material, containing better proportions of ¼ to 1¼-in. sizes was available at $1.40 per cubic yard. The former was dredged from the Ohio River. Upon a visit to the dredge, it was discovered that about one-third of the gravel was being thrown away because it was too large, averaging about 2½ to 3 in., a small amount running up to 5 in. It was decided to use this material with only the sand screened out. The results were excellent. Pouring into the center of the columns eliminated the trouble of clogging the spiral reinforcing. The few large stones which failed to pass through the column-head reinforcing readily were forced through. The astonishing feature to those who saw the extra-large material used was that, after being mixed, it was no longer noticeable. Although the usual amount of sand for a 1:2:4 mixture was used, the unscreened gravel produced an unusual surplus of good, smooth mortar which greatly lessened the labor of placing and striking off. Of course none of this concrete was tamped.

The basement floor of this building was 5 in. thick, made up of 4 in. of concrete and 1 in. of 1:1½ finish on a 6-in. gravel foundation. The gravel base was thoroughly tamped and wet before the concrete was laid. The latter was mushy but not too wet. A few of the largest stones were thrown out, but many over 4 in. in diameter remained; where these stuck above the grade they were immediately tamped down with a 20-lb. sidewalk tamper. This is an extreme case as compared to an 8-in. concrete street pavement, because what can be done in a limited space with a 5-in. slab, can certainly be done with an 8-in. slab where every facility is at hand for thorough rapid work.

EIGHT-INCH GRAVEL IN A SPILLWAY

In 1914 the writer was sent to San Antonio, Texas, to repair a spillway that had been damaged by floods. Among other necessary repairs was a section of apron to be relaid, the thickness being 10 to 12 in. Stone delivered cost $3.25 per cubic yard. In the vicinity was a large quantity of boulders from 2 in. to 8 in. in diameter. These were used in the concrete in the proportion of two wheelbarrows of the large material to one of crushed rock from 1½ in. down. The concrete was laid with no more labor than had a 1½-in. material been used entirely. It was tamped and brought to a level surface just as easily. However, tamping had to be commenced and completed as fast as the concrete was laid. This tamping was really puddling, using light, quick blows with a 20-lb. sidewalk tamper, which kept the mass quaking.

The writer has been in charge of other operations in which large aggregate was used in amounts varying from a few wagonloads to two or three carloads. He has found that it always makes better looking concrete; concrete which is more easily manipulated and which costs less. He does not want to be understood to advocate for reinforced-concrete work the use of aggregate which will not pass between the reinforcement unless the concrete foreman understands his business and is thoroughly dependable.

In the reinforced-concrete footings, including cantilevers 3 ft. thick, of the new building now being erected for the Methodist Book Concern at Cincinnati, Ohio, some concrete containing aggregate up to 4 in. was used satisfactorily and spouted on a 1:6 slope.

In the summer of 1914, and perhaps at the present time, the Florida East Coast Railroad was using crusher-run rock up to a maximum of 6 in. on the concrete arches connecting the Keys.

MACHINE MIXING NECESSARY

In every case mentioned, except the work at San Antonio, the concrete was machine-mixed. This is absolutely necessary to secure the best results. "One-man" stone and cyclopean stone are often put into the concrete after it is deposited and must not be confused with large aggregate that has gone through the mixer. Arguments supporting other methods of securing concrete, said to be as good or better than machine-mixed, with the same ingredients, are not supported by the facts. Time and again the writer has examined with great care, good practical samples of hand-mixed concrete, machine-mixed with "one-man" stone added, machine-mixed with cyclopean stone, crushed stone laid, rolled, filled with mortar and rolled again and, lastly, walls laid up with derrick-size stones, the spaces between being filled with machine-mixed concrete. Every class not wholly machine-mixed shows flaws. These vary from a size into which a knife-blade can barely be inserted, to holes large enough to toss a cat through, and are found mostly at the under side of the aggregate units.

The facts set down in this article are not to be disputed, as they are actual experiences. The use of small aggregate is our heritage from the days of dry concrete, and of course good concrete is still being made with it; but it is neither the best nor the cheapest. Highway engineers, in particular, would do well to look into the use of larger aggregate.

Corrugated Pipe Used Successfully for Culverts

Nestable Sections Found Convenient To Place Inside of Failing Timber Waterways Under High Railroad Embankments

CORRUGATED pure-iron pipe has solved the problem of how to replace failing timber culverts under high embankments on the Western Pacific Railroad without disturbing the fills. The cost of concrete would have been prohibitive and cast-iron was also out of the question on account of the difficulty of handling the heavy lengths inside the old culverts. The ability of corrugated pipe to accommodate itself to the settling of embankments and to dispense with absolutely rigid foundations was another argument in favor of its use.

During the construction of the road in 1907 a considerable number of timber culverts had been built. The timbers were of 12-in. Douglas fir. The side timbers were laid on top of each other and drift bolted together. Floor sills were laid on 4½-ft. centers. The floor planking was 4 x 12 in. Standard sizes in these culverts were 3½, 4½ and 5½ ft. square.

During the past year or two it has become evident that many, if not all, of these would soon require replacement with more permanent material. As many were installed under very deep fills, to accomplish this with concrete or cast-iron would have been very expensive. Corrugated pure-iron pipe was decided upon because it was found practicable to install this in the nestable form inside the wooden culverts and tamp the filling effectively around the pipe. This method showed a great saving over any form of construction which involved completely excavating the old work, and, from the behavior of the first installations of the kind, seemed likely to give very good service.

For this purpose the nestable Armco (American Ingot) iron culverts come in semi-circular sections 2 ft. in length, provided with a special connector for drawing half sections together, which, under these circumstances, must of course be operated from the inside of the pipe. For these installations the fill is not disturbed, but the floor of the old timber culvert is removed.

GETTING THROUGH COLLAPSED TIMBER CULVERTS

Where the timber culvert has been crushed by the weight of fill, tunneling becomes necessary. Little lagging is required, 2 x 8-in. head boards and 4 x 4-in. uprights being used instead. As the culvert is installed, the uprights are removed and the head boards allowed to remain in place. The 2-ft. sections are assembled inside the timber culvert and the backfilling and tamping accomplished as each section is put in place. This is considered an extremely important feature of the installation, and the practicability of thorough backfilling and tamping in this way was the principal reason for the choice of this form of culvert. The minimum backfill is 6 in. on the sides and 12 in. on the top.

The culverts are 36, 48 and 60 in. in diameter, these being installed inside the timber waterways of square dimensions, 6 in. greater in each case. The material is No. 10 gage. The fills vary in depth from 8 to 100 ft. or more.

Careful experiments made with this type of nestable culvert indicate that it will carry approximately 90 per cent of the load of a full-circle continuous riveted corrugated pipe; and the experience of the Western Pacific is that in the sizes and gage mentioned and with due care in installation it will give good service under rather severe conditions.

With the timber culvert cleaned out in advance, four men will lay this form of nestable pipe, per day, approximately as follows: 36-in., 40 to 42 ft.; 48-in., 50 ft.; 60-in., 30 to 32 ft.

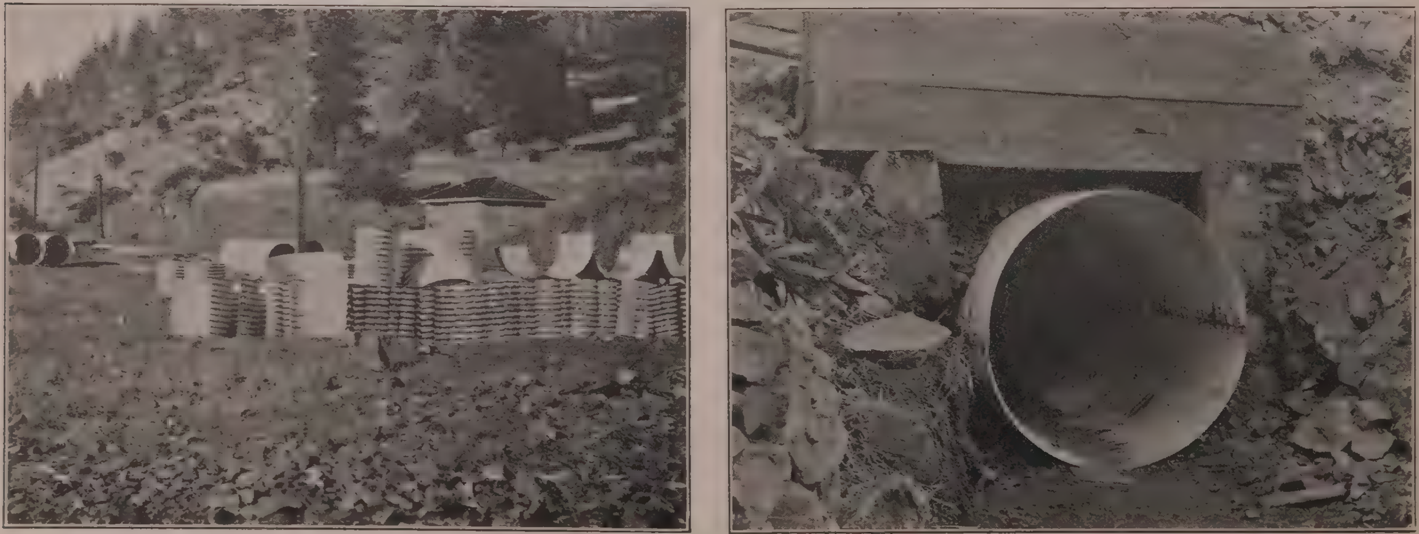
Where the fills are not more than 8 ft. deep it is found economical to excavate from the top and place full-circle, continuous riveted Armco corrugated pipe. In these cases the top and floor of the timber culvert are removed but the side walls are allowed to remain. The pipe is installed in sections from 8 to 12 ft. in length. The diameters employed are 18, 24, 30, 36 and 48 in., these being of 10-gage material. The weight of these sections will not exceed 1000 lb., even in the largest sizes. The sections are equipped with a convenient lug coupler for making the connections. These pipes are also carefully backfilled and tamped, this important part of the work being easily accomplished in the open ditch.

For both types of corrugated culvert, head walls are made of stone laid in cement, precautions being taken to prevent water getting under or around the sides of the pipe.

Approximately 8000 ft. of this corrugated pipe have been used since Oct. 1, 1914, for the replacement of these timber culverts. All of these installations are entirely satisfactory, according to a statement of C. P. Gilmore, general foreman of tunnels of the Western Pacific Railroad, who had charge of the installations and supplied the foregoing information.

How Gage Glasses Show Water Levels at Cobb's Hill Reservoir

THE water levels in the reservoir and the screen chambers at the Cobb's Hill Reservoir, Rochester, N. Y., are shown on the operating floor of the gatehouse, which is above the water surface, by a simple and ingenious system of gage glasses. The lower end of one gage glass is connected by a tube with the reservoir, a second and a third respectively with the north and south screen chambers downstream from the screens, and the fourth with a small tank, the level in which is maintained at the high-water line determined for the reservoir. At the top, the four glasses are connected to a manifold, from which a tube leads to an aspirator. By working the latter, air is exhausted from the manifold and the water columns rise in the tubes. When that in the tube connected with the tank reaches the high-water reading marked on the glass, the aspirator is shut off and the levels in the other three tubes then show how far the water surfaces in the reservoir and the screen chambers are below the high-water line. The tubes are of approximate-



AS THE NESTABLE SECTIONS APPEAR IN THE STORAGE YARD, AND AS THEY FIT INTO OLD TIMBER CULVERTS ly 1 in. bore and are graduated in feet and hundredths, the graduation being etched on the glass. "Full Reservoir" is at 25-ft. depth and as all of the 25-ft. marks are at the same elevation and the graduations are identical, simultaneous readings give actual heights of the water in the various chambers. Since the partial vacuum above the water columns has a tendency to cause the liberation of air entrained in the water, it is necessary occasionally to work the aspirator to restore the level in the high water-line tube to the standard mark. However, so long as the water columns in the tubes appear at all, the difference in levels is shown, and that, of course, is all that is needed in order to control the gates properly. The arrangement, on the whole, is somewhat more simple than the float system usually used, though it would seem to have one disadvantage in operation, due to the exhaustion of air from the water in the tubes, as above mentioned.

The Cobb's Hill Reservoir was constructed under the direction of E. A. Fisher, then city engineer of Rochester, and of John F. Skinner, principal assistant engineer.

PROTECTING MILWAUKEE'S WATER SUPPLY was the subject of a paper by T. Chalkley Hatton, chief engineer of the Milwaukee Sewerage Commission, presented before the Lake Michigan Water Commission March 19. Liquid chlorine will be used even after the 12-ft. tunnel, with its pipe intakes 5 mi. from the river mouth, has been completed. All the sewage and a portion of the storm water of Milwaukee is to be collected by a system of interceptors leading to some point, not yet selected, where a treatment plant will be erected. Funds are available and work has started on the interceptors. The complete installation of all works necessary to provide for the population expected in 1930 will require a period of six years.

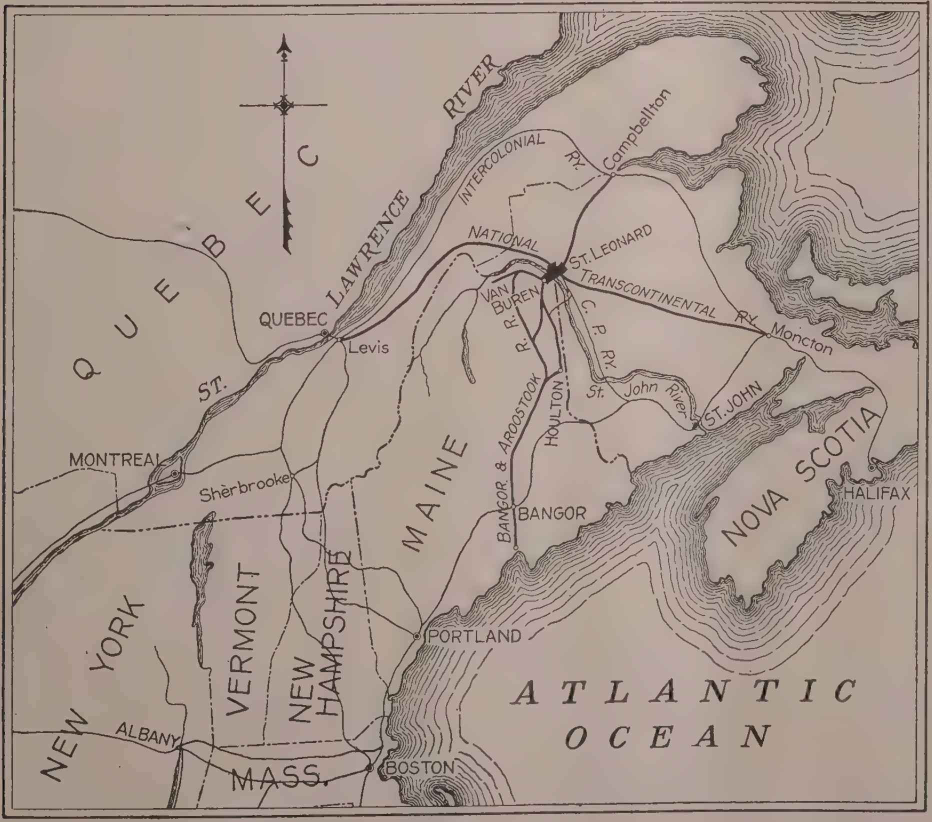
New Canada-New England Railroad Link Completed

Van Buren Bridge Route, from Northern Maine to New Brunswick, Connects Three Railroads with Only 1.36 Miles of Track

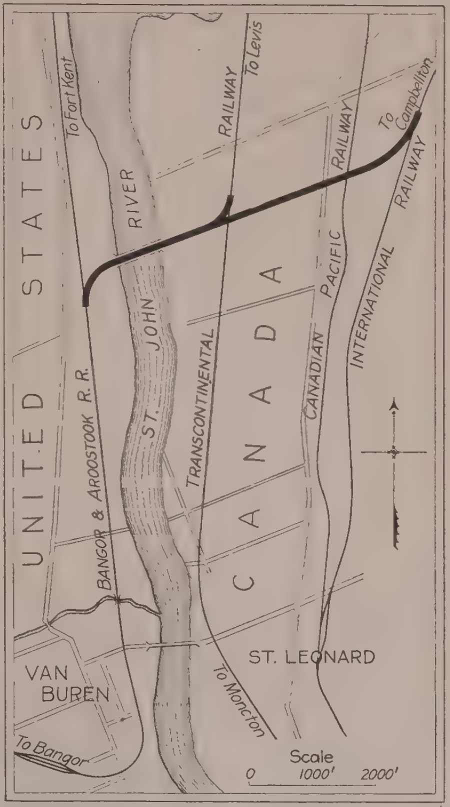
A NEW GATEWAY between New England and Canada—a link which, although 1.36 miles long, will connect three railroads and cross a fourth, besides crossing the St. John River and the international boundary line—is to be opened for service today. The line, which is known as the Van Buren Bridge Route, starts at a junction with the Bangor & Aroostook Railroad, at Van Buren, in the extreme northern part of Maine, crosses the St. John River to St. Leonard, N. B., crosses and connects with the new National Transcontinental Railway, crosses a branch line of the Canadian Pacific Railway and terminates at a junction with the International Railway, from St. Leonard to Campbellton.

ADVANTAGEOUS POSITION

The advantageous position of the new link is indicated by the general map. Heretofore the only direct trunk-line connection between Maine and New Brunswick has been the Maine-Central-Canadian Pacific route through Vanceboro, 160 miles to the south of Van Buren. This does not reach northern New Brunswick directly. Traffic between southern New England and the timber lands, lumber mills, fisheries and pleasure resorts centering at Campbellton on Bay Chaleur has been by the roundabout route along the Connecticut River and through Sherbrooke and Levis. The Van Buren Bridge Route, utilizing the direct line of the International Railway from St. Leonard to Campbellton, is more than 200 miles shorter. In addition, it affords the only connection between northern Maine and the National Transcontinental Railway.



HOW THE VAN BUREN BRIDGE ROUTE LINKS NORTHERN MAINE WITH CANADA



FOUR RAILROADS ARE REACHED BY A 1.36-MILE CONNECTION

The new line belongs to the Van Buren Bridge Company, with the exception of 0.17 mile at the Maine end of the bridge, which is owned by the Bangor & Aroostook Railroad. The river, which at this point measures 970 ft. from bank to bank, is crossed by a bridge of five single-track steel riveted lattice through spans of 160 ft. each. The base of rail is 97 ft. above extreme high water, the range in water level being 36 ft.

RAPID CONSTRUCTION OF BRIDGE

Perhaps the most marked feature of the bridge work has been the rapidity of its construction, only seven and a half months having elapsed from start to completion. Beginning in the middle of last September, excavation and the laying of concrete were vigorously prosecuted throughout the winter months, although the temperature usually hovered around zero, and was at times much lower. This was made possible by inclosing the piers in housings, heated with steam pipes and salamanders. Steel erection from the Canadian shore was started in January and followed closely on the heels of the substructure, the last pier, which was on the American side, having been completed early in April. Through the employment of the cantilever method of erection, the danger from a premature break-up of the ice in the river was obviated.

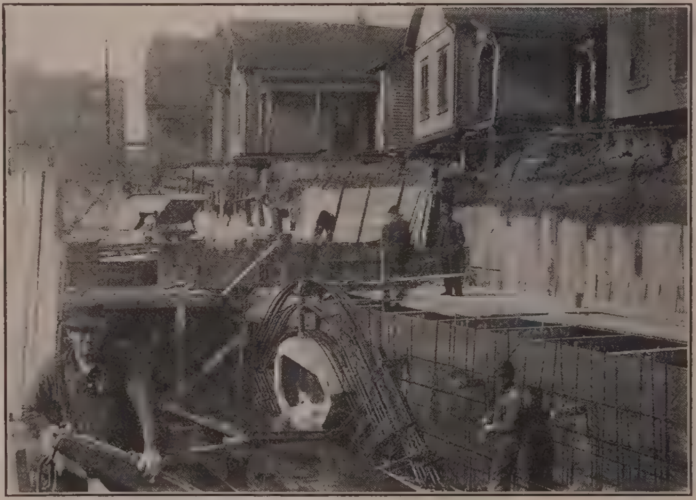
The principal contractors for the work were Cyr Brothers Company, of Waterville, Maine, for the bridge substructure; the Dominion Bridge Company, Ltd., of Montreal, for the substructure, and Hill & Hammond, of Woodstock, N. B., for the grading and trackwork. Percy R. Todd, of Bangor, Maine, is president of the Van Buren Bridge Company. W. J. Wilgus, of New York City, was consulting engineer on the work, and T. A. Lang was resident engineer.

Indianapolis Builds Million Dollar Storm-Water Drain Under Railroad Yards

Huge Double-Box Section, Preliminary to Track Elevation, Constructed by Movable Concrete Outfits Operating at Both Ends of the Work

POGUES RUN drain in Indianapolis, a million dollar preliminary to extensive track elevation construction in the heart of the city, is now well under way. The contractor is building this huge double-box section, 12,000 ft. long, with movable concrete outfits at three different points. Mounted towers and mixers on rollers in the trench lay the heavy invert slab following excavation by steam shovels. The concrete for the walls and the roof is prepared in a mounted mixer located on top of the previously constructed work. The latter mixer discharges into industrial cars which are pushed by hand out over tracks laid over the bent-up reinforcing bars immediately above the side and center walls. Excavated materials are removed and concrete aggregates are hauled in over a narrow-gage railroad alongside.

FILTHY CONDITION OF POGUES RUN BEFORE RECONSTRUCTION



OVAL EQUALIZER IN CENTER WALL OF NEW WATERWAY

As a preliminary to track elevation in the vicinity of the Union Station it was necessary to care for Pogues Run, which is a small meandering wet-weather creek which had been confined partially between masonry walls about 36 ft. apart. A small amount of sewage entered the creek, making the total dry weather flow from the 7760 acres drained 5 sec. ft.

Designed for Storm Water Only

On account of this small flow and the financial arrangements whereby the railroads pay a portion of the cost absolutely no sewage will be carried in the reconstructed channel. At present the approximate maximum storm flow is 2500 sec-ft. and with the flat grades of 0.15 and 0.2 per cent permissible a maximum of 3015 sec.-ft. has been provided for. This amount is estimated to care for a downpour of one hour's duration at a rate of 3 in. per hour. Of the area served 50 per cent was considered impervious. It is not expected that the drain will ever be taxed beyond its capacity, but back-water from the river is likely to submerge the sewer for 7000 ft. back from the outlet. Levees are to be built along the river, but back-water gates across the drain will not be built, as the high water level is much lower than any inlets into the drain.

Three departures have been made from the existing course of the creek. At the outfall a short cut to White River near Kentucky Avenue eliminates a meandering course of more than 1 mi. To obviate the difficulty of construction under the Union Station, where the stream now runs, the new conduits will be built for two blocks in Meridian Street, one block to the east of the station. Another departure of ¼ mile eliminated a bend in the abandoned stream bed.

Since much of the drain is laid under railroad yards and the character of the future occupancy is indefinite the reinforcing is particularly heavy in these sections. The fill for the most part is not heavy but in a few places it reaches 35 ft. above the bottom of drain and the 1⅛-in. bars are spaced on 3½-in. centers.

For the most part the section is two rectangles 8 x 18 ft. but near the outlet there are sections 1 ft. wider and near the upper end, because of steeper grade obtainable, two 8 x 16-ft. boxes are used. The outside walls are from 18 to 20 in. thick and the center wall is 24 in. thick. The invert and roof, usually 21 and 24 in., is at points under railway embankments 32 and 34 in. thick. Every 100 ft. oval openings are left in the center wall to equalize the flow in the two channels.

Construction was started at the outfall, a flaring concrete apron 2½ ft. thick beyond a headwall resting on piles. As soon as the work reached the former stream bed the normal flow was diverted by pumping into convenient sewers in the upper stretches. Storm water had to be carried through the new work.

Excavated Sand Used in Concrete

Practically all of the excavated material was sand or small gravel and was handled by steam shovels to dump cars on a track along the trench. At some points buildings were so close to the line of the drain that the track had to be laid in detours through streets and alleys. The sand and gravel were hauled to make back-fill or if suitable to the outfall, graded through a screening plant and then returned to the concrete mixers. To reload the screened materials and the gravel which came by rail from local pits the contractor utilizes a locomotive crane operating a 1-yd. clamshell. Three dinkies and sixteen dump-cars furnish the transportation service. Wherever possible available switch tracks crossing the drain near the work are utilized to bring cars with gravel near the work. One outfit only was used up to April 1 when a second shovel was installed near the Union Station and a third shovel at Virginia Avenue, each plant being equipped with the necessary mixers, towers and transportation service.

Order of Procedure

The order in which the concrete work is prosecuted is as follows: On the first day a 60-ft. section of invert is to be placed from the plant in the trench, which consists of a tower and ¾-yd. mixer both mounted on one platform near the upstream end of the slab, while carpenters are building forms for a 60-ft. section of walls and roof slab. The invert work is kept three sections ahead of the form work.

On the second day the invert gang will run one section of walls and roof with a ¾-yd. mixer on top of the completed section, which is also mounted on rollers and is moved ahead every two days. The weight of material and mixer, therefore, does not come on the green roof concrete until it has set two days. Reinforcing steel is placed during the night for the roof slab, and the same day the invert mixer is moved and grading is completed for another section of the invert slab. Steel is also placed for the invert slab during the night, light being furnished by carbide and gasoline lights.

The third day another section of invert will be laid while forms are built and the mixer is moved ahead ready for another section of roof slab and walls.

On the fourth day another section of roof slab and walls will be placed by the same force and preparations completed for another section of invert. It is the practice to remove the forms four days after the roof concrete has been deposited.

Ordinarily sheeting is not required. In some of the narrow and deep sections it is braced entirely across the trench and used as side wall forms. By the time the workmen are ready to set the inner wall forms and roof floor, the concrete in the invert has set sufficiently to support the sheeting at the bottom thus permitting the removal of the cross bracing and a transference of the load at the top to the forms.

Hand-Operated Steel Bender

From 30 to 40 tons of steel are bent per day by hand. Eight to sixteen men are employed at this work. The rods are placed on a table between angle irons and pins. A steel tool, 2 x 2½ in. in cross-section, with a transverse slot in it is set down over the bar near the point of support. Five men on the end of a gas pipe, slipped over the handle of the tool, furnish the power.

Work has progressed throughout the winter, the average amount of concrete per 10-hr. day during February being 200 yd. A fair day's run is 300 to 350 yd. which means an advance of 38 to 40 ft. As the work gets nearer the Union Station, with some of it in tunnel and some in deep open cuts in streets, between heavy buildings, much less rapid progress is to be expected. The contract, however, calls for the completion of the drain by July 1, 1916. On April 1 the work was 25 per cent complete and 30 days ahead of the necessary schedule.

CONCRETING INVERT FROM TOWER AND ROOF FROM MIXER ON COMPLETED WORK; CAR TRACKS SUPPORTED BY STEEL REINFORCEMENT

The work is being carried out under the direction of B. J. T. Jeup, city engineer, and D. C. Hayne, assistant city engineer. J. W. Stearns, civil engineer, and F. C. Lingenfelter, track elevation engineer, are directly in charge of the work for the city.

The Dunn-McCarthy Company are contractors for the entire work. For the contractor, T. R. Mead is superintendent and J. B. Hall is engineer.

The Consumption of Water in Columbus, Ohio, in 1914 was 87.5 gal. per inhabitant, 90.9 gal. per consumer and 552.6 gal. per tap, according to the annual report of the Water Department. Of the total amount 62.7 per cent passed through meters. For pump slip 1 per cent was allowed, and 5 per cent was lost through under-registration of the meters. The percentage sold by flat rate was 8 per cent. About 0.7 per cent was given away and 23.6 per cent is unaccounted for. Of the 32,383 services in the system, approximately 95 per cent are metered.

Engineers Present Recommendations to Constitutional Convention

Joint Committee Representing National and Local Engineering Societies Sends Proposals to New York Convention

Believing that technical developments have introduced into government problems in connection with public works and utilities which were not so important twenty years ago, when the present constitution was adopted, a joint committee representing National and local engineering societies has made recommendations to the New York Constitutional Convention, now in session, with reference to matters and departments affecting or concerned with engineering work. As noted in this journal of March 20, 1915, page 382, and, editorially, on March 27, page 385, a committee of the American Society of Civil Engineers began work on the subject some time ago. Since the matter was discussed at the house of the society March 17, a joint committee has been formed, the whole subject gone over thoroughly and the recommendations adopted sent to the delegates to the convention. Represented on the committee are the American Society of Civil Engineers, the American Institute of Electrical Engineers, the American Society of Mechanical Engineers, the American Institute of Consulting Engineers, the American Institute of Mining Engineers, the Municipal Engineers of the City of New York and the Brooklyn Engineers' Club.

The recommendations in a general way follow those discussed at the meeting on March 17 at the house of the American Society of Civil Engineers. There are, however, material modifications. The chief recommendations are that the office of State engineer and surveyor be abolished, that a department of engineering and public works take over all the State's engineering work, that a single department of public utilities replace the two present public service commissions, that engineers compose one-third of the membership of the court or board of claims, that there be no prohibition against courts retaining experts on cases involving technical matters, and that a reasonable conservation policy be adopted.

The principles which the committee believes should be observed and the recommendations are as follows:

Principles to be Observed

The Constitution should insure:

(a) A short ballot, making possible close scrutiny of the qualifications of all candidates and concentrated responsibility of elected officers.

(b) Tenure of office for all elected officials, for heads of departments, and for bureau heads, of sufficient duration to attract competent men and to permit them to become increasingly efficient in the discharge of their duties.

(c) A continuing policy in the organization and control of all departments, so that appropriations may be spent most economically and work carried on most efficiently.

(d) Selection of heads of departments by appointment instead of election by popular vote.

(e) Ample opportunity for the proper development of natural resources.

(f) Recognition of the value of technical advice through the inclusion of professional engineers in the membership of departments or courts where such advice is essential to the proper conduct of the work or adjudication of the matters involved.

Recommendations

1. The elective office of the State engineer and surveyor should be abolished, and the duties should be transferred to the Department of Engineering and Public Works hereinafter proposed.

2. A Department of Engineering and Public Works should be created to be headed by three commissioners appointed by the Governor, each to have a twelve-year term of office so arranged that a vacancy will be created every four years immediately after the inauguration of a new Governor. Commissioners should be eligible for reappointment. At least one commissioner should be a professional engineer in good standing in

his profession, and each should have had experience that would fit him for the duties of the office. At least one and not more than two commissioners should be residents of New York City.

This department should have charge of public lands and boundary surveys; of buildings, parks, highways, canals, and other public works, including design, construction, maintenance, and operation; and of the conservation and development of State resources.

This department should be divided into suitable bureaus. Each bureau charged with responsibility for engineering work should be headed by a chief engineer selected by the commissioners with sole regard to his peculiar fitness for the duties of the bureau.

DEPARTMENT OF PUBLIC UTILITIES

3. A Department of Public Utilities should be created to be headed by five commissioners appointed by the Governor, each to have a ten-year term of office so arranged that a vacancy will be created every two years. Commissioners should be eligible for reappointment. At least two commissioners should be professional engineers in good standing in the profession. Each appointee should have had experience in connection with public utilities which would fit him for the duties of the office. At least two and not more than three commissioners should be residents of New York City.

This department should regulate and supervise all common carriers, all water supply, irrigation, drainage, gas, power, lighting, heating, intelligence-transmitting and other public utility corporations operating within the limits of New York State, including similar activities on the part of any other State department or political subdivision of the State.

This department should be divided into such bureaus as may be essential. Each engineering bureau should be administered by a chief engineer selected with sole regard to his peculiar fitness for the office, and he should have power, subject to the approval of the commissioners, to select and appoint such division engineers as are essential to the proper conduct of his office.

4. In case provision be made in the constitution for the creation of one or more departments or commissions charged with responsibility for regulating, supervising, and inspecting buildings and the equipment thereof, trades, mines, industries or labor, each such department or commission should include in its membership at least one professional engineer in good standing in his profession. Commissioners should be appointed by the Governor. Each appointee should have had experience and should possess qualifications fitting him to perform the duties essential to the department or commission.

COURT OR BOARD OF CLAIMS

5. In case provision be made in the constitution for the creation of a Court or Board of Claims charged with responsibility for investigating claims against or on behalf of the State, one-third of the membership of such court or board should be made up of professional engineers in good standing in the profession, each to have practised professional engineering for at least ten years and for at least five years to have had responsible charge of important engineering work either as to design or execution.

6. Removal by the Governor of any commissioner should be made only after the filing of charges and after affording the accused an opportunity to be heard in the matter, provided, however, that at any time within the first six months after making an appointment the Governor may exercise the power of summary removal. A successor to a commissioner who has been removed should be appointed to fill the unexpired term. Vacancies caused by removal or otherwise should be filled under conditions similar to those governing original appointment.

7. There should be no direct or implied prohibition against legislation which would permit the reference by a court of technical matters made the subject of, or incidental to litigation, to a referee expert in such technical matters, for the purpose of securing a determination concerning the facts, or which will prevent the court from selecting independent expert witnesses or advisers in matters of this character.

8. In order to make possible the reasonable development of State resources, the present constitutional prohibition against the use or sale of land and cutting of trees within the limits of the Forest preserve should be removed in so far as such use or sale of land or cutting of trees is essential to such development (Article VII, Section 7), and similarly to permit the development of other natural resources by private enterprise, provision should be made for the condemnation of private property necessary to the construction and operation of works for irrigation, drainage, sanitation, water supply, agriculture, mining, forestry, or power development, through the declaration of such project as *for public use*, subject, however, to the superior right of the State or of a subdivision thereof to condemn the same property or a portion thereof for State or municipal purposes (Article I, Section 7).

THE COST OF REPAIRING A BREAK in a 16-in. water main in Milwaukee 22 ft. below the surface of the North Menominee Canal was $1,323.45. The break occurred last August at a point 30 ft. from the dock line. Boats plying the canal draw 19 ft. of water, but they were not the cause of the accident, according to H. P. Bohmann, superintendent of waterworks, inasmuch as an inverted sewer lies intact 18 in. above the water main. A crack was found the full length of the pipe removed, and a large section on the bottom was broken out entirely.

Mixer on Connecticut Road—A Correction

IN the article on the Milford Turnpike, between New Haven and Bridgeport—the 4¼-mile road with only one crack—published in the Engineering Record of April 17, 1915, page 480, it was stated that a Koehring mixer was used. This was an error. The mixer was built by the Chain Belt Company, of Milwaukee. The error is all the more regrettable since the Chain Belt Company took especial pride in the performance of this mixer, many contractors in New England, at its suggestion, visiting the work to see the mixer in operation. The contractors, C. W. Blakeslee & Sons, of New Haven, in writing this journal regarding the error, state that they are well pleased with results from using the Chain Belt machine.

Graphic Method of Detailing Hip-Rafter Connections

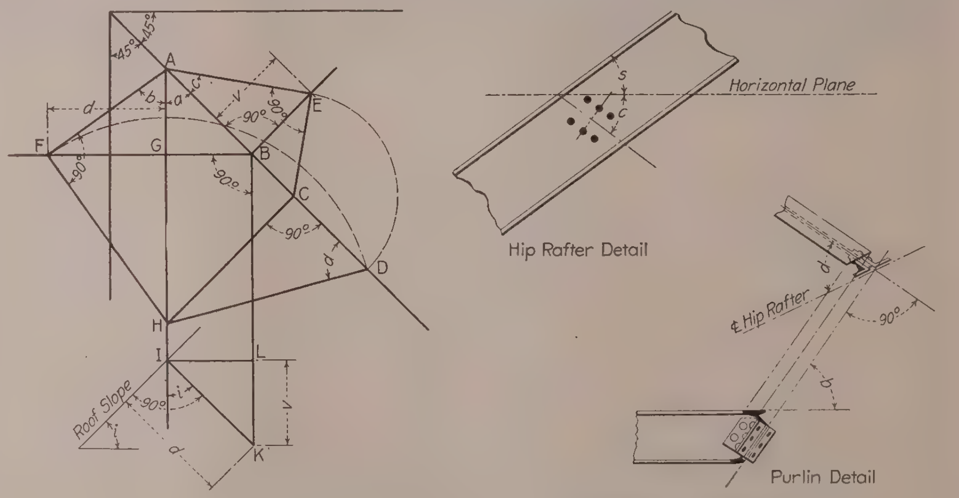
Simple Construction for Determining Angles of Intersection of Purlins and Hip-Rafters and Bevels for Connections

By C. L. C. MAGEE
Scully Steel & Iron Company, Chicago

A GRAPHICAL method for determining the correct angles of intersection, and the inclination and bevels of the connection angles for hip-roof and similar problems is here presented in a concise form, which is believed to be simpler than the usual trigonometrical solution.

Assuming a typical roof with I-beam hip rafter and beam or channel purlins flush on top, there is known i, angle of slope of roof plans or top flanges of purlin; s, angle of slope of hip rafter; a, angle between plane of hip rafter and vertical plane through purlin (usually 45 deg. as shown); d, depth of purlin; and the depth of hip rafter. The angles required for detailing, which are to be found by graphical construction, are b, c, and d as shown on the accompanying sketches. The construction can be made as follows:

Draw the lines HA and AD to represent the horizontal projections of the upper axes of the purlin and of the hip rafter respectively. Select any point I on HA, and draw the line IK at the angle i with IH. Lay off IK = d = depth of purlin to any convenient scale, then draw KB parallel to HA to intersect AD at B, giving the point



GRAPHIC CONSTRUCTION FOR DETAILING HIP-RAFTER CONNECTIONS where the center line of the lower flange of the purlin pierces the hip plane. From B lay off BF perpendicular to HA and make $FG = IK = d$. Connect the points F and A, and at right angles lay off FH to intersect HA at H. The angle b is found at A.

Similarly, at B, lay off BE at right angles to AD and equal to $KL = v$ and connect AE, which should be equal to AF for a check. This gives the angle c at A. Then draw EC perpendicular to AE and connect CH, which should be at right angles to AD for a check. Swing an arc with C as a center and radius CE to give D, connect DH, and the angle d is found at D. For a check, swing the arc FD with H as a center. The sketches of the details of the purlin and hip rafter show the application of these angles b, c and d to the detailing of the connections.

The construction is based on the principles of projection and revolution of planes to give true values of angles. The line of intersection of the plane of the purlin web and the plane of the hip rafter is shown in true length as AF and AE revolved into a horizontal plane (IL), giving the true angles b and c. A plane is then passed perpendicular to this intersection line by using the two perpendicular lines EC and FH, the true angle d also being found by revolution into a horizontal plane, using HC as an axis. It should be noted that IK could be given any convenient length, regardless of the depth of purlin, as the construction is independent of the scale used. This method can also be applied to skew portal connections to end posts, and to the connection between the horizontal struts of bracing and sloping tower columns.

Literature

For the Civil Engineer and Contractor

New Publications

INDUSTRIAL CONDITIONS IN TOPEKA.—Part IV, The Topeka Improvement Survey. Report by Zenas L. Potter, Department of Surveys and Exhibits, Russell Sage Foundation, New York City. Paper, 6 x 9 in.; 56 pages; 7 illustrations and 12 tables. Topeka, Kan., Topeka Improvement Survey Committee.

THE CITY PLAN, March, 1915, Vol. 1, No. 1. Paper, 6 x 9 in.; 16 pages. Boston, National Conference on City Planning.

First issue of a quarterly published as the official organ of the National Conference on City Planning to present discussion on city-planning problems for the benefit of those interested in this phase of municipal engineering.

STATISTICS OF RAILWAYS, 1903-1913, UNITED STATES. Issued by the Bureau of Railway Economics. Paper, 6 x 8¾ in.; 81 pages; 76 tables and a map. Washington, Bureau of Railway Economics.

Compiled from data published annually by the Interstate Commerce Commission, and published to present for convenient reference aspects of railway operation as shown thereby.

Books Reviewed

The Operation of Sewage Disposal Plants

Author, Francis E. Daniels, A. M., director of water and sewerage inspection, Board of Health of the State of New Jersey. Board, 8 x 5 in.; 136 pages; 40 illustrations. New York, Municipal Journal. $1.50.

Reviewed by George A. Johnson

Consulting Engineer, New York City

Inefficient management of sewage disposal plants is unquestionably responsible to a far greater degree than faulty design for their failure to produce satisfactory results. It seems a pity that city officials will spend large sums of money on the construction of such works and after their completion "point with pride" to them for a year or less, and afterward sit up nights devising ways of cutting down appropriations for their management. It is not so with water purification plants, except perhaps in some small works, but it is all too true of most sewage disposal plants.

The author of this little book, as director of the department of water and sewerage inspection of the State Board of Health of New Jersey, has had for years an excellent opportunity to study the management, or perhaps more properly the mismanagement, of sewage disposal plants; and the volume he has written as a result of his observations and experiences possesses more real value for sewage works managers and city officials than any book on the subject which has appeared in a long time. As a matter of fact, for reasons not altogether clear, writers of books on sewage disposal more often than otherwise confine their comments regarding management to generalities, which of course have but a limited value.

If those having in charge the management of such works, and also the officials whose duty it is to prepare and see passed the annual budgets of their cities, would read this book carefully and take good heed of the advice therein given, they would not fail to profit materially from the slight effort thereby entailed.

In the reviewer's opinion this is a book which should be in the hands of every sewage works manager and in every city hall library. It contains much sound common sense, is simply written and is replete with forceful, convincing arguments. There is need, great need, of more books of the same type.

Federal Valuation of Railroad Property

Author, Richard J. McCarty, M. Am. Soc. C. E., M. Am. Soc. M. E., vice-president of the Kansas City Southern Railway, Kansas City, Mo. Paper, 5½ x 8½ in.; 103 pages. Kansas City, Tiernan-Dart Printing Company.

Whoever has read Mr. McCarty's shorter monograph, "Depreciation of Railroad Property," issued a year ago and reviewed in the Engineering Record of Feb. 14, 1914, page 202, will make it a point to read this new discussion of valuation. Combining a simplicity of presentation with frequent recapitulation and summary, and the use of large type, numerous subheads and simple numerical examples, Mr. McCarty makes his writings thoroughly readable and easily understood. Withal he uses certain terms and angles of attack which, while perhaps dismaying to those who deplore the lack of a universal code of definitions and first principles, give his writings a decidedly individual flavor.

This new monograph is not a general discussion of the principles of valuation. The author confines himself strictly to his title, railroad property and the Federal valuation thereof. He begins with the Valuation Act itself and its general purposes. Of these general purposes he finds four: To discover whether there is overcapitalization, to establish data for the problem of government ownership, to determine whether investors in railroads receive proper returns, and to provide a basis for future legislation. He admits freely that rate regulation may be taken as the chief special purpose of the act, and his aim is to show what constitutes "fair value" for this purpose.

As in the earlier discussion of depreciation, Mr. McCarty favors "original cost" rather than "reproduction cost," passing over without comment the difficulty of ascertaining it from the average railroad's records. He now elucidates his theory, however, and introduces modifications of the actual cost which make his final value about that obtained by the reproduction method; in fact, he admits in his brief discussion of the latter that it is compatible with his principle of "proper original cost" provided present prices and original conditions are assumed. This "proper original cost," from which he excludes wasteful or dishonest expenditures, is the foundation of his theory of fair value. He allows increments, however, not only in the value of land, but also in that of material and of labor, so that the resultant unit price is virtually that of reproduction new. He also allows adaptation and solidification as real elements of value.

In discussing "undivided interest in joint facilities," and co-ordination and co-operation, the author brings out some valuable ideas on matters about which little has been written. He thinks it not feasible in many cases to make terminals and other independently organized joint properties self-supporting, and would divide them theoretically among their owners as elements of fair value to the parent companies, disregarding the separate entity of the joint property. He shows in an interesting manner how when two companies by a co-operative contract, as for a piece of track or a joint station, are able to give with the one physical unit as good service, or better, as with duplicate facilities, a fair return will include enough to maintain the duplicate facilities.

His discussion of property abandoned is another part of the book especially worth reading. He shows that where an obsolete or inadequate part has been replaced for the betterment of the service the costs of both old and new parts, less the salvage value of the old, are legitimate items of "fair value." Only when the abandoned part has not been replaced, and not always then, would he exclude it.

Fifteen pages are devoted to depreciation. The author follows the general line of reasoning adopted in his earlier work on that subject, that in order to avoid wasteful renewals, with the first indications of depreciation the property must be built with a reserve strength. While there may be little really new in this section of the discussion it might clarify the ideas of some.

Other phases of the general subject are touched upon, and altogether Mr. McCarty has produced a work that no one concerned in valuation, particularly railroad valuation, can afford to ignore.

HINTS FOR THE CONTRACTOR

Details Which Save Time and Labor on Construction Work

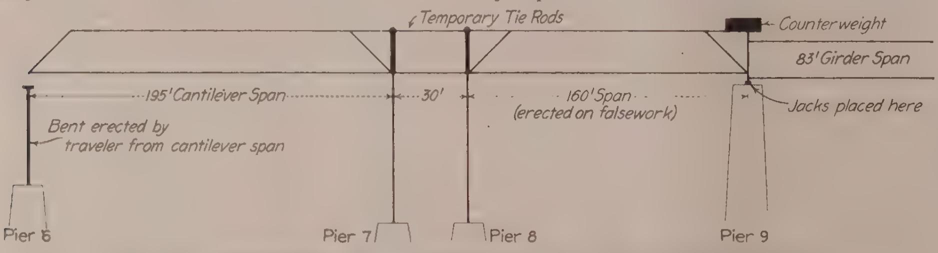
Other articles in this issue of interest to contractors and construction engineers are indexed in the Table of Contents

[*Contributions to this section are solicited, and if found available will be paid for. They must be* SHORT, *and should be accompanied, if possible, by photographs or sketches.*—EDITOR.]

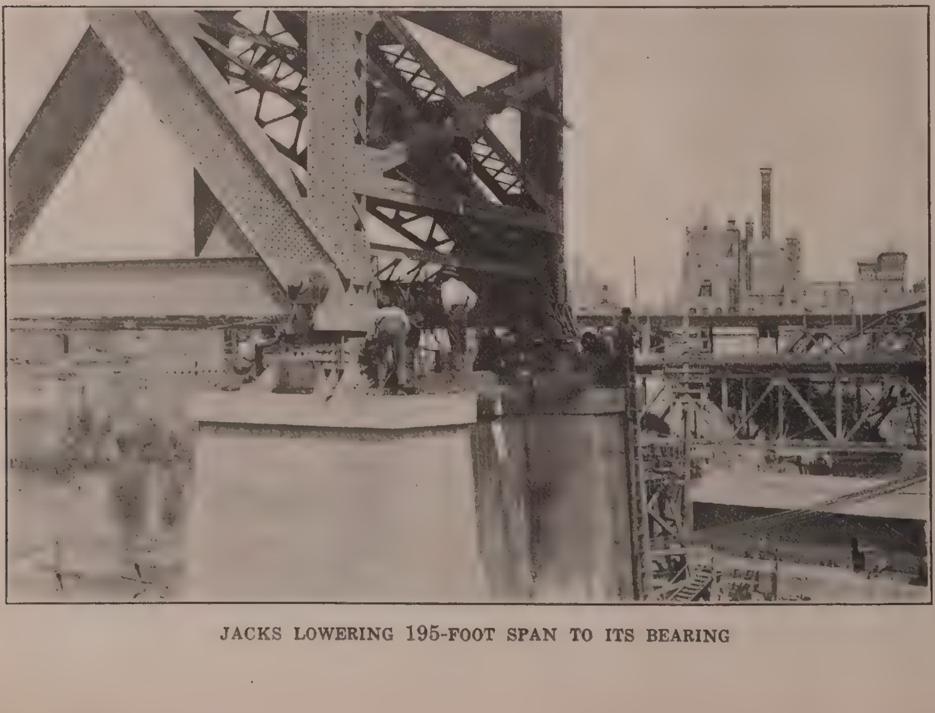
Long Bridge Truss Erected from Short Weighted Span

IN erecting a 195-ft. deck truss span over the Spokane River at the crossing of the city's Monroe Street viaduct in Spokane, the contractor for the viaduct belonging to the Chicago, Milwaukee & St. Paul Railway employed falsework under a 160-ft. connecting span, loaded it with 1,000,000 lb. of rails and then proceeded to erect the long span as a cantilever. The overhanging end landed 10 in. above its supporting bent, which was erected from the traveler on the cantilever span as noted in the Engineering Record of Feb. 20, page 235. Temporary tie-rods 5 in. shorter than the lower chord were inserted between the top chords of the connecting spans to make the cantilever span land high. Later these rods were replaced by girders. To lower the 195-ft. span to its bearing the counterweighted end of the anchor span was jacked up. Then the counterweight was removed, the temporary rods removed and the short span jacked down to its final bearing plates. Men operating the whiskey jacks are shown in the photograph.

The Bates & Rogers Construction Company were the contractors for this work.



END OF CANTILEVERED SPAN LANDED HIGH BY SHORT ERECTION TIES



JACKS LOWERING 195-FOOT SPAN TO ITS BEARING

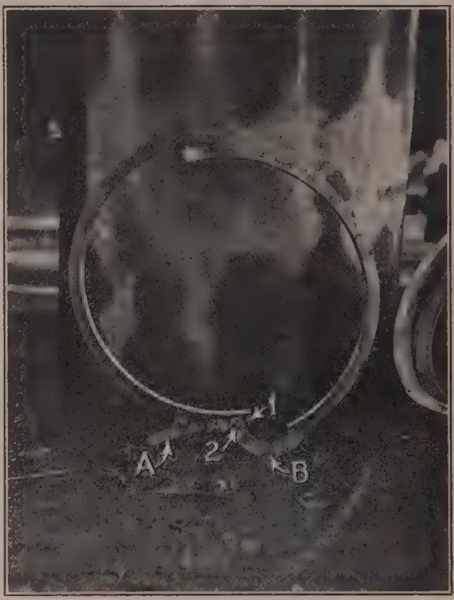
Pipe Coil Hung Overboard Cooled Air For Memphis Caissons

THE Mississippi River was used as an air cooler in sinking the caissons for the Memphis Bridge. A floating compressor plant, including three 2500-ft. machines, was used to supply air to the caissons. In warm weather, of course, this air had to be cooled. This was readily accomplished by hanging over the side of the compressor boat in the river several lengths of pipe fitted together with return bends. This coil was connected into the main air line so that all air going to the caisson passed through it.

Ring Used to Clamp Column Forms Can Be Quickly Removed

A QUICKLY adjusted and readily removed form support has been used by H. I. Moyer in repairing columns in the buildings of the Edison plant recently damaged by fire. The clamp has proved equally useful on new building work.

One of these rings, made of light angle-iron, is shown in the accompanying photograph. The method of using it may be readily understood by referring to the picture. To place it around the column the key is removed from the slots in the link and half-ring at the top of the picture. The ring can then be opened up, fitted around the column, brought together again and the key replaced in the slot. The lever *A* is not then in the position shown in the photograph, but is thrown to the right, increasing the gap between the two angle rings at the bottom of the picture by twice the distance between hinges 1 and 2. The lever *A* revolves around the pin 1, and the link *B* is hinged to the lever by the pin 2. To clamp the ring tightly the lever *A* is thrown to the left until it is tight against the left-hand angle ring. This brings the hinge 2 a very slight distance closer to the center of the column than hinge 1, thereby locking the ring in place around the form. To remove the ring, it is only necessary to pull out the lever *A*, slacking the ring, and then take out the key on the opposite side of the column.



FORM RING EASILY SET AND LOCKED

Dig Out Base of 100-Foot Chimney by Hand—Then Run!

WITH the advent of active building operations in the central part of large cities in restricted quarters the wrecking of existing structures in an economical and safe way presents many problems to the wrecking companies. In St. Louis recently a building was wrecked in 48 days to make way for a new 22-story building. Razing the 100-ft. chimney was left to the last so that the bricks might fall on space comparatively well cleared from which they could be recovered in a minimum of time. The method used by the contractor was to cut out the bricks from slightly over half the base and permit the chimney to topple over into the space prepared for it. The chimney was 6 ft. square at the base and had a slight taper. Four picked men were selected who would obey orders implicitly, as their own safety depended upon escape from the base of the chimney after it began to fall. Four layers of brick were removed, starting 2 ft. above the foundation at the center of the side facing toward the direction in which it was desired the chimney should fall. Two of the laborers held

6-ft. chisel bars while the partner of each used a sledge.

It was necessary, according to the contractor, to have a horizontal distance at least 25 to 40 ft. greater than the height of the chimney into which to topple the chimney, as bricks might fly that far.

As soon as the work began, at 5 a.m., a watchman with a pair of glasses took up his position 150 ft. away. It was his duty to keep his eye continually on the top of the chimney, as any movement could be detected there first. Once or twice before the chimney actually began to fall he tried the laborers by sounding a false alarm on his whistle, thus giving them a sort of practice drill, as every second counted in the rush to cover the distance to a point of safety. The chimney fell without mishap at 6:10 a.m. after the cut had been made slightly more than half way through.

Detailed Advance Planning, Properly Done, Cheapens Construction

COSTS can be cut by planning in the home office or the construction office the details usually left to workmen and foremen. In a paper presented recently before the Western Society of Engineers by Sanford E. Thompson and William O. Lichtner it is shown that one firm engaged in reinforced-concrete building work cut costs on form work alone by the use of these methods from 7¾ cents to 5½ cents per square foot. The methods outlined have been applied with equally striking results to several classes of construction.

According to this method, such planning includes not merely laying out the installation of heavy machinery, the successive moves of derricks, etc., but also planning the delivery of material and all the different moves to be made by individual gangs from the start to the finish of the job.

SEQUENCE OF WORK STUDIED

First, the entire job, including all temporary as well as permanent structures, is studied from beginning to end, and detailed plans of everything to be made on that job are worked out. Next, the sequence of the job is planned from beginning to end, and every construction operation, down to the successive erections of temporary platforms, planned. Then a purchasing schedule of every item that will be used is made, and transferred to material slips showing what is to be needed, when it must be ordered, and to what spot on the work it must be delivered. A schedule is made showing the number of men and foremen of each trade required from start to finish to accomplish the work as it is laid out on the progress schedule. So far as possible (and the farther it is carried the better it pays) the amount of work to be done by each gang, and even each man, is reasonably laid out for each day, and cash bonuses are provided for exceeding the estimated day's work. Finally, the superintendent and the force at the job must see that materials arrive as called for on the schedule; that the proper number of men are provided; that work starts at each particular part of construction on the proper date; and that each foreman and man understands in advance exactly what he is to do and how he is to do it.

There rests with the superintendent and his force the task of training the foremen and workmen in the most efficient methods of going at their work. If the men's moves are planned in advance in this way, and the right materials and tools delivered to them at the proper place and time, and cash inducements offered them to develop their efficiency and exceed their schedule, the work will be in no danger of lagging behind the desired progress.

This plan, of course, requires that the designing force be in much closer touch with the construction force than is the case with most contracting firms. The planners, of whom the superintendent should be one, must be men with engineering knowledge, but also men who know construction work thoroughly and who are capable of laying out schedules without any of the absurdities so often found in such plans.

Heavy Needling for 450-Ton Column Loads for Subway Underpinning

THREE 450-ton single column loads are being temporarily supported on 30-in. 200-lb. girder beams in the cellar of the Centurian Building, 1182 Broadway, New York, while their footings are carried down to the platform subgrade of the new subway.

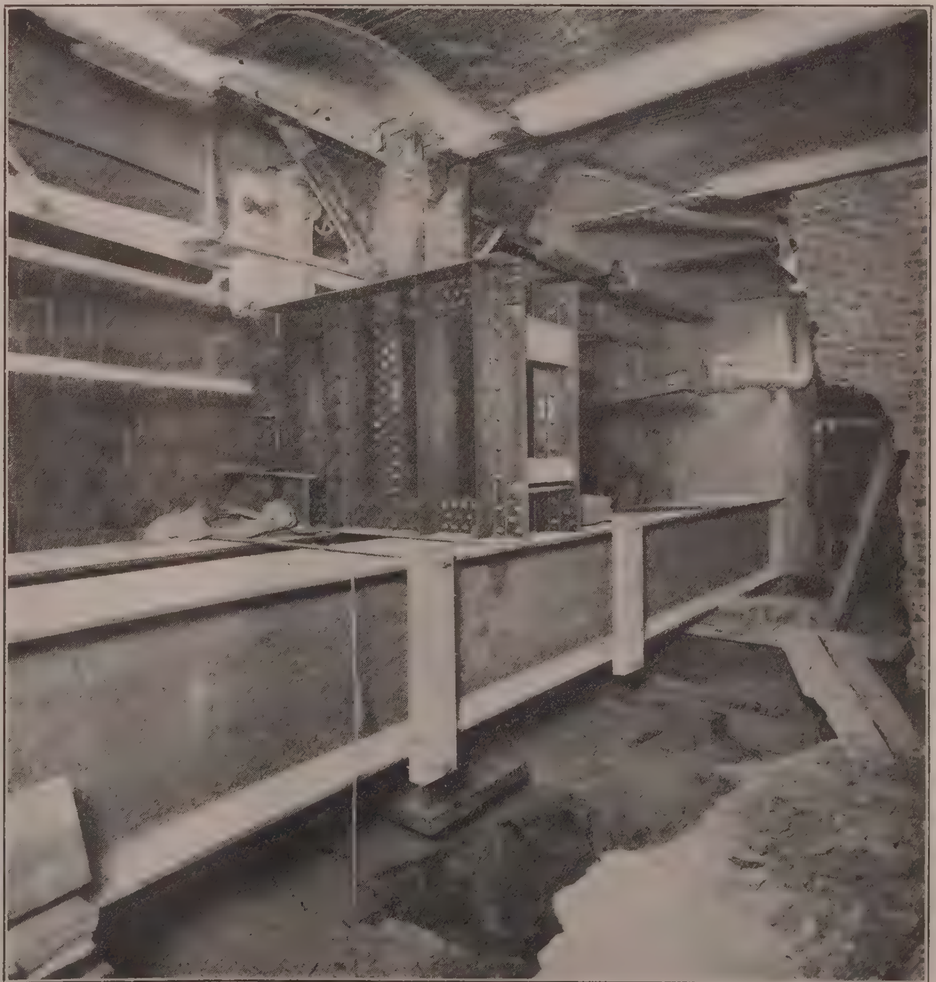
Single-column loads of this size rarely are met with in underpinning. The fact that solid rock was found a little below the street in constructing this building is responsible in this case for shallow footings under such heavy loads. The building has no subcellar, and the column footings are only 15 ft. below the street. Pits 8 ft. deep are being dug beneath each of the three southerly columns and filled with reinforced concrete to underpin them to subgrade. The footing of the north column had already been carried down because of the depth of the adjacent subcellar under the Hotel Breslin. To support the columns while the construction was carried out required careful planning by the contractor.

The short 55-in. girders supporting each column could not be made deep enough to get enough rivets in the column flanges to take the heavy shear, because of brackets at the top of the columns supporting the floorbeams. A triple line of 1-in. bolts was therefore put through the columns, as indicated in the drawing.

CONSTRUCTION DETAILS

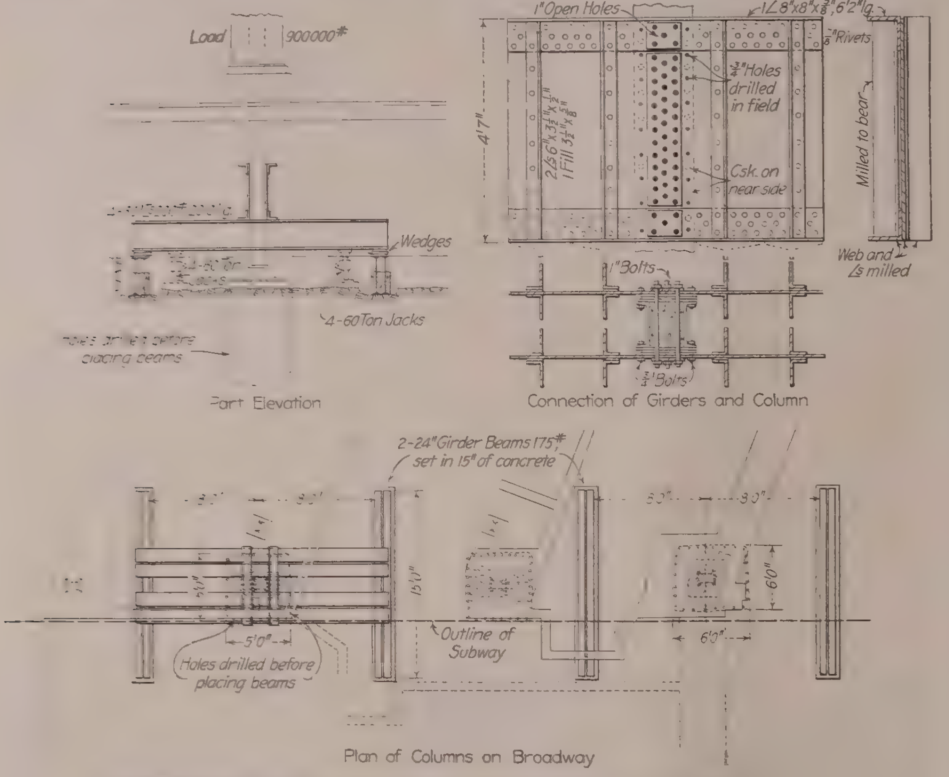
The old column rivets over the space covered by the short girders were first cut out, a few at a time, and countersunk on the outside. Meanwhile vertical holes were drilled all around the old footings to provide breaking faces for the pits excavated later. The four cross beams to carry the main girders were also placed in shallow trenches, cut through the cellar floor into rock and half filled with concrete.

Next the four main girder beams were set, the short cross-girders placed against the column faces and holes for the 1-in. bolts drilled through the columns. These bolts were inserted, and the interior of the column filled with cement mortar by a grout machine attached to an opening drilled in the web of one of the channels. As soon as this set, the 1-in. bolts were drawn up to a good grip on the column, without danger of buckling the webs of the column channels. Every other one of the column rivets previously countersunk was



COLUMN GRIPPED IN SPITE OF SHORT SPACE BELOW BRACKETS then drilled through and replaced with a ¾-in. bolt gripping both the girder and the column flange.

As soon as the short girders were properly attached to the columns, eight 60-ton jacks were set to take up the deflection in the girder beams. In the case of the column shown in the photograph this deflection was first taken up, accurate levels being taken on the ends of the girder beams, during jacking to measure the theoretical deflection necessary just to lift the weight of the column. The column itself was then actually raised a few thousandths of an inch, and a saw blade inserted under the cast base of the column. After standing over night on the wedges, the girder beams were found to have deflected until the saw blade was caught under the column. The girder beams were then jacked up till the saw blade was loosened, and the process repeated once or twice, till these beams showed no further deflection.



Part Elevation

Connection of Girders and Column

Plan of Columns on Broadway

DEEPENING THREE SHALLOW FOOTINGS UNDER LOAD OF 450 TONS EACH

The grillage beams were then removed from the old column base, and the rock below cut out to the required depth with jack hammers. Concrete is poured into the footings through chutes from the street.

The support of one of two small columns behind the two middle main columns is partly shown in the photograph. It is much lighter and simpler than the main needling, and was only undertaken to prevent the chance of the 40-ton load breaking down one side of the pit dug to underpin the large column. These 40-ton columns are back of any possible cleavage slope of the rock, and their footings did not have to be deepened.

This work is on section 2 of routes 4 and 36, being constructed by the U. S. Realty & Improvement Company, for whom C. H. Stengel is chief engineer, E. A. Little, general superintendent, and S. S. Jones, field superintendent of the section. For the Public Service Commission, Edward Pendlebury is section engineer under J. O. Shipman, engineer of the first division.

Progress Map Records Accurately Water-Main Construction

CONTRACTORS' records on water-main contracts are probably more difficult to keep than those in any other form of construction work. The line of work stretches out over a very extensive territory and the chances of omission of insignificant items, which in the total sometimes amount to serious figures, are great. This is especially so in the case of contracts in large cities, where there are often as many as fifty items in a job that does not exceed $100,000 in the price bid.

During the past five years a contractor's engineer evolved a system which has proved to be accurate to as great a degree as is practically desirable, which is extremely simple, and which does not require a great amount of time. A roll of cross-section paper proportionate in length to the length of the pipe line to be covered is all that is necessary. The center line of the proposed main is laid out along this in pencil to a scale of 1 in. to 20 ft. In case of city work, the width of street should be laid out and the property lines shown. All this can be readily and quickly transferred from the original blueprint. Then, as the pipe is laid, it can be sketched out on this map in pencil, also to scale. Branch connections should be shown and all small items of work, such as concrete, vitrified drains, sewer alterations, house connections, extra width and depth of trench, extra width of paving removed, and such other items as are called for in the contract. These should be noted at their proper places along the pipe-line. In this manner a daily record of progress can be kept, all possibility of duplication of entries eliminated, and a complete record of the job can be had upon its completion. In case of dispute, the entry in question can be found at its proper location along the pipe line and the fact that the item of work was actually done proved by showing the reason why it was necessary to do it, which is usually quite enough when dealing with a fair-minded engineer. In cases where additional payment is made for extra joints beyond one in every 12 ft. of pipe line, a very satisfactory record is available at no additional cost.

This system was used on a water-main contract in a large city in which more than $400,000 worth of work was completed in about eleven working months. It required but an hour's office work a day and the notes were gathered, incidentally, in the course of the superintendent's daily round of the job. At the completion of the contract two men went over the maps, one to make up the final estimate and the other to check his figures. It required a month to do this, and the result was an estimate that was the means of bringing the city engineer's estimate up several thousand dollars and of saving to the contractor that sum which would have otherwise been lost, due to carelessness on the part of inspectors in failing to report certain items of work that had been performed.

Recently the same system was used on a large scale in open country work. It took even less effort on this contract as there were fewer small items to be noted and the survey station points could be used as points of reference instead of property lines as in city work.

Tall Stack on Contractor's Boiler Prevents Smudging Building

HAVING as fuel a pile of pitch-filled lumber, the builder of the Miami Hotel in Dayton, Ohio, decided that it would be much cheaper to carry the smoke stack from the hoisting engine boiler up above the top of the building than to clean the soot from the brick work and terra cotta trim after construction was completed. The stack is shown in the photograph alongside the material tower. Frank Hill Smith is the contractor and engineer.

TALL STACK SAVES EXTERIOR FINISH OF DAYTON BUILDING

NEWS OF THE WEEK

Passing Events in the Civil Engineering and Contracting Fields

Construction to Start on New Subway in Philadelphia

Present Appropriation for Work Near City Hall on Main Line—Construction Will Be Decked Trench Work in Gravel

The citizens of Philadelphia on April 29 voted on a $6,000,000 bond issue to begin the construction of the new $46,000,000 subway system planned for that city. It will be at least a month before any contracts can be let under this issue. A $500,000 bond issue was voted last fall and applied on five contracts for deepening and enlarging sewers in the downtown district enclosed in the proposed delivery loop of the new system. Much of this sewer work would have been necessitated without the subway by the increasing number of large buildings in this district with deep cellars which were not drained by the present system, and with an increasing volume of sewage which was rendering the present system inadequate.

The present Philadelphia subway, as described in the Engineering Record of March 14, 1914, page 308, runs east and west under Market Street, and terminates in a short north and south elevated line along the river front. The new subway will cross under the present one at the City Hall, and will extend north and south under Broad Street. A delivery loop, which is in the form of a rough square about ½ mile on a side, will provide for discharging the flow from the subway at a number of points in the business district. Track construction in which all grade crossings have been eliminated will provide for routing trains from either direction by or around this loop with great flexibility. All the appropriation voted at the present election will be applied to the construction of the Broad Street line, and work on the loop will be provided for under future bond issues.

Construction Features

On account of the flatness of the part of Philadelphia traversed by this subway, it has been possible to secure favorable grades and at the same time make the roof of the subway support directly the street surface, thus eliminating all settlement and trouble due to back filling. At the point where the new subway crosses beneath the present Market Street subway, the space between the roof of the subway and the street will be left open and one use suggested for it has been the parking of the automobiles which now stand each day in a long line down the center of Broad Street.

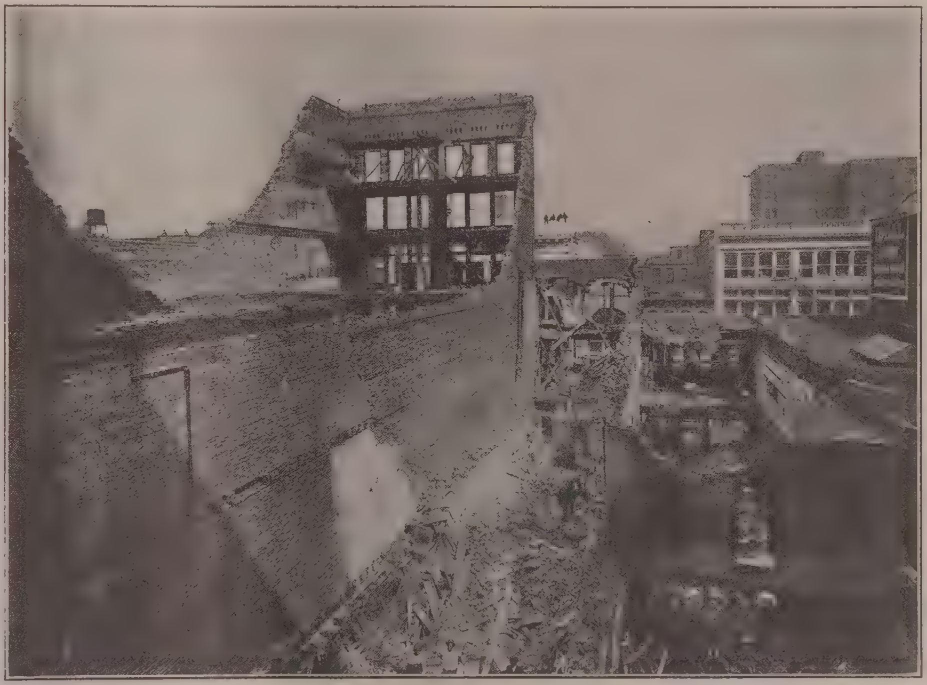
The excavation for the new subway will be mostly in gravel, and there will be no difficulty in securing excellent footing for the structure. Part of the work on North Broad Street will be in rock cut. One of the interesting features of the construction will be underpinning the City Hall, which is a very heavy building with solid masonry walls. This work was easily arranged in the construction of the old subway, as the tubes divide and circle the building. The new tubes will go directly beneath it.

As will be remembered from the article referred to above, the daily urban passenger movement of the population of Philadelphia, present and prospective, has been thoroughly tabulated and mapped. In addition to the construction which will go forward at once, other rapid transit subway and elevated lines are included in the comprehensive plans of the Department of City Transit for the future.

Wind Wrecks 5-Story Wall Which Resisted Fire

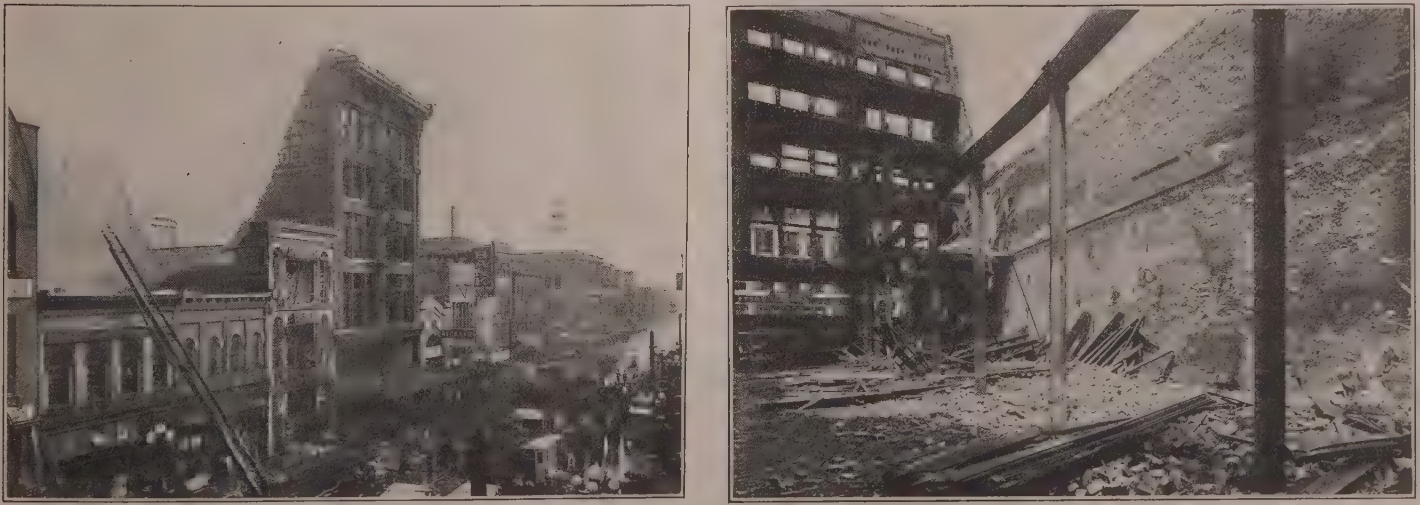
Steele-Smith Brick Building at Birmingham, Alabama, Collapses During 35-Mile-an-Hour Gale, Damaging Adjacent Shops

Unable to resist wind blowing at a velocity of 35 miles per hour the east wall of the Steele-Smith five-story brick building in Birmingham, Ala., which had remained standing after a fire in December, 1914, and was used in the reconstruction of the store, toppled over at 5 P. M., April 21, killing eight people and injuring twelve. Fire broke out in an adjacent shop, upon which the debris had fallen, and escaping gas from a broken pipe added to the danger, although the flames were quickly extinguished.



IN FALLING THE EAST WALL DEBRIS DEMOLISHED TWO ADJACENT STORES

The Steele-Smith building, according to information received from R. P. Partridge of the City Engineers' Office, of Birmingham, was 50 x 140 ft. in plan, 70 ft. high, with



GAP IN THE EAST WALL AFTER THE FAILURE AND VIEW OF THE INTERIOR OF THE DAMAGED STRUCTURE brick walls 13 in. thick at the top and thicker at bottom; cement mortar with lime was used. The building was about ten years old.

After the fire last year the débris was cleaned out and such portions of the walls as were considered unsafe were torn down. About one-third of the west wall above the third floor was down, the fire being hotter on this side than on the east side, owing to the location of the elevators. The east wall remained standing, part of it being practically unscorched and paint still on it in places, and practically all of the front and rear walls were left standing.

Fire-Damaged Walls Examined

An architect and contractor carefully examined these walls and decided to use the east wall in reconstructing the building and therefore left it standing undisturbed, as it was found to be in perfect alignment, not cracked, well tied and plumb, and was adjudged by them to be safe under ordinary conditions. Joints were examined and they were found to be in regular formation. No brick had fallen from the east wall at all.

When the accident occurred the wind was blowing from the west at 35 miles an hour and the two upper stories of the east wall fell eastward. Apparently the third story was kicked westward into the burned building. The two upper stories of the east wall fell on a three-story building, 25 x 140 ft., occupied by the Hann shoe store, and a two-story building on a lot 25 x 140 ft., occupied by the Atlantic & Pacific Tea Company. Both of these buildings were constructed of brick and were much older than the Steele-Smith building.

Adjacent Shops Damaged

The east wall of the Steele-Smith building was not a party wall, but in falling carried with it the upper story of the west wall of the Hann shoe store, and went completely through the tea store. The roof and all floors of each of these stores were carried down to the ground floor, neither of them having a basement. This location being in the heart of the retail district of the city, there were many shoppers, especially in the tea store.

Since the disaster it has been decided to take down all of the remaining walls, which are now considered unsafe.

Reclamation Service Establishes Executive Office in Field

Executive offices have been established by the U. S. Reclamation Service at Denver, Col., which will handle all matters pertaining to work in the field.

First Water Over Roosevelt Dam

The reservoir behind the Roosevelt dam in Arizona was filled and water passed over the spillway for the first time on April 15, as noted last week. Elaborate ceremonies had been planned and were attended by about 2500 people. Addresses were delivered by several members of the State legislature, and Louis C. Hill, who was construction engineer for the U. S. Reclamation Service on the project, briefly reviewed the history of the work and pointed out the opportunities which it opens up to the Salt River valley. The first water over the crest was preserved and is being forwarded to New York in a flask of Arizona copper. This water is to be used instead of champagne in christening the new dreadnaught "Arizona." The accompanying pictures showing the spillways in service are published through the courtesy of A. P. Davis, chief engineer of the Reclamation Service.

RESERVOIR FILLED TO SPILLWAY LEVEL

FOR THE FIRST TIME IN THE HISTORY OF THE ROOSEVELT DAM WATER PASSED OVER THE SPILLWAYS ON APRIL 15

$3,675,000 Only Available for New York State Barge Canal

Instead of the $8,720,000 provided by the MacDonald bill to continue the work on the New York State Barge Canal, on which the Legislature failed to act, the improvement has been allowed only the sum of $3,675,000 in the general appropriation bill now awaiting the signature of Governor Whitman. During the closing hours of the legislative session, however, it was voted to call for a referendum on a bond issue of $27,000,000 to complete the entire canal program. It is believed that the smaller sum made available will be sufficient to obviate cancelling any existing contracts.

Heavy Travelers Erect Hell Gate Arch Over East River

Single Hitch Used for Heaviest Members—Water Delivery of Steel—Unloading Derricks and Dinkeys Handle Steel for Backstays

Four panels of the main arch for the Hell Gate bridge of the New York Connecting Railroad across the East River have been erected on the Long Island end, and the work of erecting the backstays on both sides of the river is going forward rapidly. On the Long Island side the backstay erection is nearly complete, while one pair of vertical members remains to be set, requiring two moves of the traveler to bring the structure on Ward's Island up to the abutment. One 175-ton and two 75-ton single-boom travelers are erected at present, as shown in the photographs.

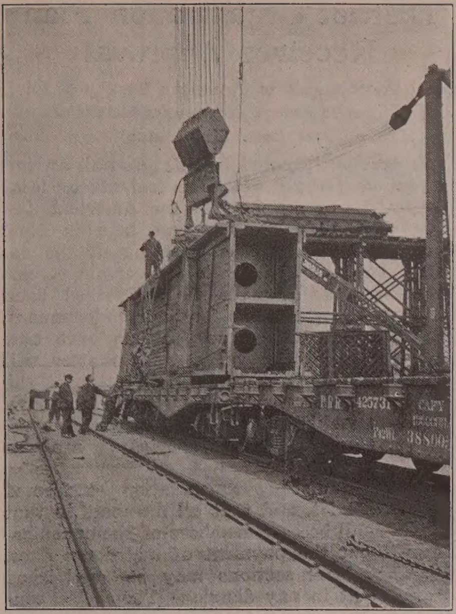
Two 12-part falls of heavy manila rope are used to move the travelers up the inclined top chords of the backstays. A stiffleg derrick is engaged in loading with sand the girder grillage which counterweights the Long Island side of the arch. The foundation work for the Ward's Island anchor arm was completed later than the similar work on Long Island, and consequently work on the west of the river is at present being rushed to catch up.

The exact point on the top flange of each chord member which is over the center of gravity of the member as it hangs at the proper inclination for entering was determined in advance, and holes were left in each member for bolting on the lifting angles. These angles in turn are attached by pins to shackle-bars hanging from the lower block on the main falls. The inclination for entering the lower chord members is the same as their permanent inclination in the structure, while the top chord members must be entered at an angle with the horizontal greater than their permanent inclination, and then swung down to engage the top of the next outer vertical post, which is erected first. The kegs of bolts and tools placed on each member for the connecting gang do not seriously disturb the balance of these sections, but a runner line of 20 tons capacity is provided to overcome any tendency to hang at a wrong inclination.

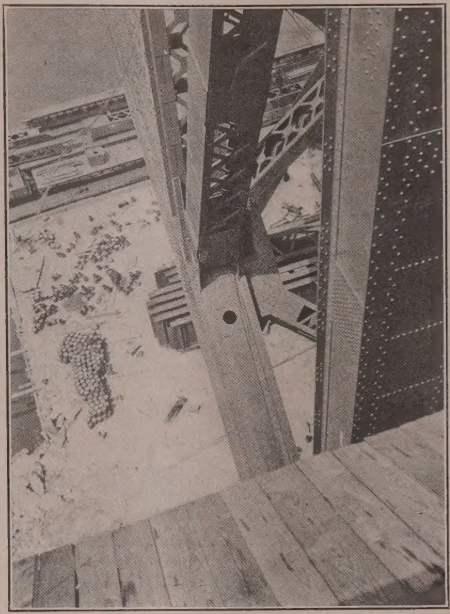
Delivery of Steel

Steel is delivered on railway cars brought on car floats up the East River, and the steel for

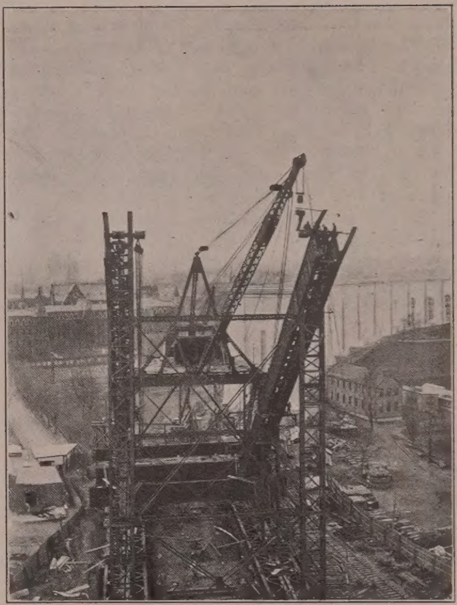
Progress Views of Hell Gate Bridge Erection, New York



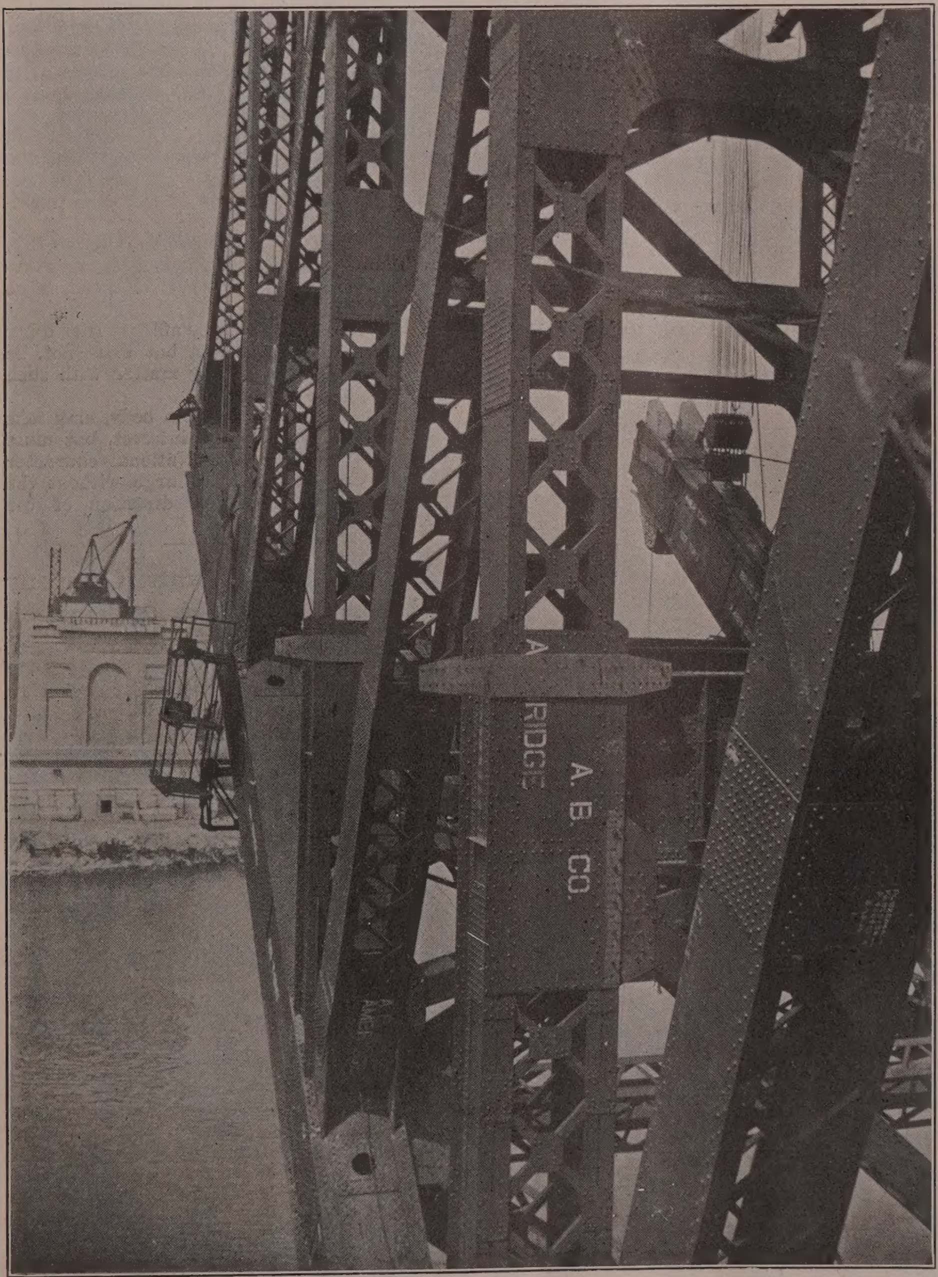
137-TON MEMBER ON CAR FLOAT



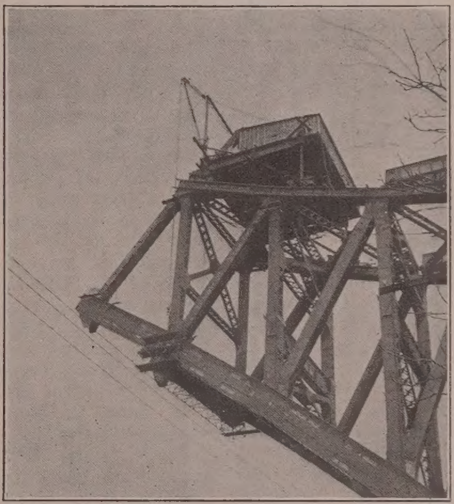
HOLE GIVES ACCESS TO INSIDE OF CHORD



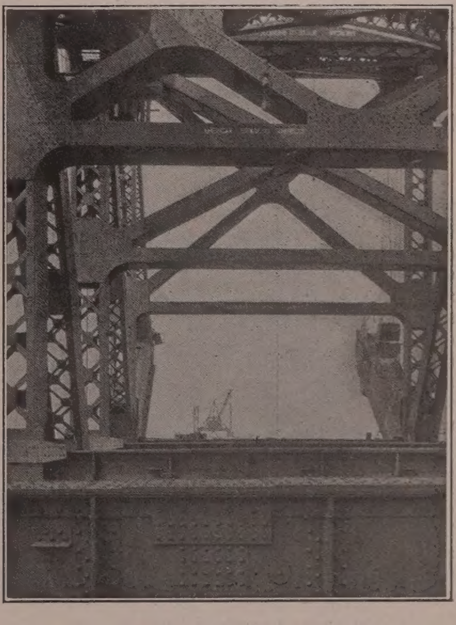
TRAVELER ON WARD'S ISLAND BACKSTAY



MEMBERS OF HELL GATE BRIDGE OVER EAST RIVER, NEW YORK CITY, ARE SO LARGE THAT MEN CANNOT CLING TO THEM—RIVETING STAGES, SHOWN AT LEFT, ARE USED



THREE-STORY RIVETING STAGES, HOLDING FOUR CREWS EACH, AND BRIDGE FOR DRIVING HANGER-PINS GIVE IDEA OF SIZE OF MEMBERS



LOOKING THROUGH AT TRACK LEVEL FROM LONG ISLAND ABUTMENT most of the arch will be lifted directly by the main travelers into place. The heaviest members to be placed weigh about 175 tons. The arch will be completed and swung before erection of the hangers and floor system is begun, as most of the material for the latter is now doing duty in the backstays. Of 6000 or 7000 tons of metal in each anchorage only 800 tons will not be used after their removal in some other part of the bridge or its approaches.

Beside the main travelers, a heavy steel stiffleg derrick is set on each side of the river to unload and transfer to cars the steel for the backstays. These members are carried under the erection traveler by standard-gage dinkies.

Unveiling of Noble Portrait the Occasion of Personal Reminiscences

To those who were present at the ceremony of unveiling a portrait in oils of the late Alfred Noble at the Engineers' Club, New York City, on April 22, there was afforded an opportunity of listening to reminiscences which indicated in what high regard the dean of the American engineering profession was held by his many friends. The program included addresses by J. Waldo Smith, who spoke for the civil engineers, Prof. F. R. Hutton, representing the mechanical engineers, and H. F. De Puy, who dealt in an intimate way with Mr. Noble's camping trips in the woods along Lake Superior.

After the formal addresses had been made the remainder of the evening was given over to stories of the human side of Mr. Noble's character. Even on his fishing trips he could never forget that he was an engineer. He weighed and measured every day's catch, plotted curves showing the relation of length to weight of brook trout, and even went so far as to develop an equation expressing this relation. A convincing demonstration of his high technical ability was afforded by one incident. While away on one of his trips in the woods the Government wished his advice on an important construction problem. As no means of reaching him by wire existed one of the ships of the Federal Light House Service was especially commissioned to patrol the shores of Lake Superior in search of him. The vessel proceeded slowly around the lake, constantly blowing its whistle, until Mr. Noble was found and brought back from his vacation to attack the technical problem in hand.

Alfred Noble's Alma Mater to Honor His Memory

The regents of the University of Michigan have appointed a committee for the consideration of some form of memorial to its distinguished graduate, the late Alfred Noble, class of '70. Action will be taken in May.

Explosion in Sewage Detention Tank Kills One, Injures Two Others

Karlson Le Rue, a councilman of South Bound Brook, N. J., was killed and Raymond Stryker, also a councilman of that municipality, and Walter C. Bowen, sanitary engineer of New Brunswick, N. J., were severely burned as a result of an explosion that occurred April 25 in the gate chamber of one of the tanks used for the treatment of sewage in Ocean Grove. They were engaged in making an informal inspection of the sewerage works of Belmar and Ocean Grove, accompanied by Clyde Potts, consulting engineer, of New York, who designed and supervised the construction of both works and who is at the present time retained in a similar capacity in South Bound Brook. The tank, which is the larger of two used for the purpose of detaining Ocean Grove's sewage a sufficient period to permit of its liquefying and which was described in detail on page 54, Engineering Record, Jan. 8, 1910, is of reinforced concrete and was not damaged in any way.

It had not been the intention to enter it, as the authorities of Ocean Grove are very particular in regard to the observance of the Sabbath and there were no attendants on hand, but some of the younger men raised the manhole cover and Mr. Stryker expressed a desire to descend. He had reached the floor of the chamber and Mr. Le Rue was half way down the ladder when the explosion occurred. Mr. Bowen had just started to descend. One of the men evidently struck a match to light a cigar, as the cigar, with a small part of its end already consumed and a box of matches were found on the vault floor the following morning. It is the opinion of Mr. Potts, who had started to walk away in the company of Mayor Baldwin of South Bound Brook, that the match ignited an accumulation of illuminating gas that had found its way in by means of the sewer pipe.

Heavy Rainfall Causes Floods in Austin, Texas

Floods caused by an excessive rainfall on the night of April 22 swept through Austin, Texas, and neighboring cities, drowning a score of people, wrecking houses and washing out bridges. According to a dispatch from Frank S. Taylor, resident engineer for Lamar Lyndon, consulting engineer for the Austin dam, 10 in. of rain fell in 24 hours, of which 8 in. was precipitated in 7 hours. Two of the creeks running through the city overflowed their banks, causing property damage estimated at half a million dollars. All railroad traffic was halted by washouts.

A second heavy rainstorm occurred on the night of April 24. Excessive precipitation on the Colorado River watershed caused the water to rise high above the dam which has just been completed. The 14-ft. automatic flood gates, according to Mr. Taylor, worked perfectly.

Flood Damages Bridges in Southwest

Heavy rains in Texas, Oklahoma and New Mexico during the past week have flooded the Canadian and the Detroit River valleys, and have washed out parts of several bridges over the Canadian River. Approximately 300 ft. of the Rock Island Railroad bridge now in course of construction about 6 miles southeast of Geary, Okla., were destroyed. The work of sinking the concrete piers for this new bridge has just been completed, but none of the steel superstructure was in place, so that only about $2000 worth of damage is estimated. One panel of the recently completed wagon bridge across the river a mile below the railroad bridge was also swept away, the remainder of the bridge being saved by steel cables made fast to trees on either bank. Twenty-two bents of the Canadian River bridge of the Fort Worth & Denver Railroad were also swept out, but repairs were immediately begun and traffic resumed within a few days. The Frisco Bridge between Fay and Thomas had forty-two pile bents washed away, many others being badly twisted and bent.

Baltimore Filters Nearly Completed

Following closely upon the announcement of the opening this month of the new St. Louis filter plant, comes the news that Baltimore's new mechanical filters are about ready for service. The Baltimore plant was designed by James W. Armstrong, who will describe some of its features in the Waterworks Number of the Engineering Record next week.

Bombay Hydroelectric Development Formally Opened

The plant of the Tata Hydroelectric Power Supply Company, Ltd., at Bombay, India, was formally opened Feb. 8.

District Organization Plan Receives Approval

Local Associations of American Society of Civil Engineers Indorse Recommendations of Presidents' Conference

As previously noted in this journal, an important conference of the presidents of local associations of members of the American Society of Civil Engineers was held in New York during the annual meeting of the society. This conference adopted certain recommendations which were then referred back to the local associations for their endorsement. Practically all of the associations have now indicated their approval and the matter will therefore go to the board of direction of the society in order that appropriate action may be taken, making the plan effective.

The recommendations, briefly, are as follows:

1. That a distinct organization be formed in each district, and that all members in that district shall become members of the organization without the payment of additional dues.
2. That local sections may be established at any point in any district. They shall consist of 25 or more members, except that in special cases the district organization may authorize a section to be formed with as few as 15 members.
3. That representatives of districts on the board of direction shall be chosen by the corporate members in that district.
4. That the society shall provide enough funds to cover the business expenses of each district organization.
5. That action taken or approved by the district organization shall be published by the society for the information of the whole membership of the society.
6. That the annual convention be held in each district in turn, except when extraordinary conditions make another location more desirable.
7. That local sections may affiliate with other local technical associations, but must not, as a body, take action on any matter with such organizations.
8. That a local section, as a body, may take action on matters of local interest, but must not act on matters of a National character affecting the profession at large without the approval of the board of direction of the society.

Jersey Court Holds Water Company Liable for Typhoid Epidemic

In sustaining a verdict of $750 recovered by B. Henry Jones against the Mount Holly Water Company, the Supreme Court of New Jersey on April 15 upheld the obligation of a water company to furnish its patrons with pure and wholesome water. There are several similar suits pending against the concern as the result of an epidemic of typhoid fever early in 1912.

"Water is a necessity of life," said the court, "and one who undertakes to trade in it and supply customers stands in no different position from a dealer in foodstuffs. He is bound to use reasonable care that whatever is supplied for food or drink shall be ordinarily and reasonably pure and wholesome."

To Make Files of Technical Periodicals More Accessible

Under the auspices of the library of the United Engineering Societies, New York, and with the co-operation of other libraries, there is now being prepared a catalog of sets of technical periodicals in the engineering libraries in New York and its vicinity. It is expected that there will be some 2400 entries. After this catalog is published it is hoped to extend it to libraries in other sections of the United States and in Canada. With the aid of such catalogs, engineers can quickly learn what periodical material is available in their vicinity and where periodicals of restricted circulation—and what volumes of them—may be consulted.

There is also a movement on foot to make a subject classification of all engineering knowledge, replacing the present very inadequate classification in the Dewey decimal system, and such attempts as have been made to supply its deficiencies.

Engineers Figure Prominently in Refugee Relief Fund

Engineers have a large part in the recently formed Refugee Relief Fund. Dr. Alexander C. Humphreys, consulting engineer and president of Stevens Institute of Technology, will direct the work of the organization as president, and Guy E. Tripp, chairman of the board of directors of the Westinghouse Electric & Manufacturing Company; B. E. Sunny, president of the Chicago Telephone Company; H. M. Byllesby, president of H. M. Byllesby & Company, of Chicago, and Gen. George H. Harries, president of the Louisville Gas & Electric Company and of the Omaha Electric Light & Power Company, are members of the general committee.

The purpose of the organization is to relieve the need of destitute men, women and children among the war refugees, especially with reference to medical and hospital supplies. It will also be prepared to aid in the tranportation of these supplies to the afflicted localities, though it is probable that it will be relieved entirely of that part of the task by the Commission for Relief in Belgium, whose activities were outlined on page 538 of this journal, April 24.

Western Society of Engineers Holds "Students' Night"

The Western Society of Engineers on April 16 held a "Students' Night," in Chicago, at which the determining factors of a successful career were discussed by J. G. Wray, chief engineer, Chicago Telephone Company; W. H. Finley, chief engineer, Chicago & North Western; O. P. Chamberlain, vice-president, Chicago & Western Indiana; Ernest McCullough, consulting engineer; C. F. Loweth, chief engineer, Chicago, Milwaukee & St. Paul; C. A. Morse, chief engineer, Rock Island Lines; Isham Randolph, consulting engineer; W. L. Abbott, chief engineer, Commonwealth Edison Company, and B. F. Affleck, president, Universal Portland Cement Company.

Ohio Senate Kills Bill Hostile to Flood Prevention

By a vote of 23 to 8 the Ohio Senate on April 21 rejected the second Garver bill, which sought to create an elective directorate for the Ohio Conservancy District and to give to the owners of land in reservoir sites the sole right to say whether they would lease or sell. The Senate's action is believed to forecast the downfall of any anti-flood prevention measure that may be proposed later.

Culebra Cut Becomes Gaillard Cut

By an executive order signed April 28 by President Wilson the name of Culebra cut, Panama Canal, has been changed to Gaillard cut, in honor of Col. D. D. Gaillard, who died from illness contracted on the construction work.

General Goethals Honored by British Engineering Society

The Institution of Civil Engineers (British) elected Major-General George W. Goethals an honorary member at the meeting held April 13, in London. The late Alfred Noble was similarly honored by this society in 1911.

News of Engineering Societies

The Municipal Engineers of the City of New York will make an excursion to the Brooklyn Rapid Transit School of Instruction for Motormen and Conductors, to-day.

The Canadian Society of Civil Engineers held a meeting April 22. A paper on "Tests on Shearing Resistance of Reinforced-Concrete Beams," by E. Brown, H. M. Mackay and C. M. Morssen was presented and taken as read.

The Engineers' Club of St. Louis held a meeting in that city, April 28. Charles A. Hobein, Jr., presented an illustrated paper on "The Investment Banker and the Engineer," and Oliver W. Childs presented a short paper on "The Work of the U. S. Office of Public Roads."

Personal Notes

W. L. Wilson has been appointed engineer of the park department of Springfield, Ill.

Leigh E. Stevens, until recently city engineer of Grand Rapids, Mich., will engage in a general engineering practice in Sioux Falls, S. D.

Paul E. Kressly has resigned from the offices of city manager and city engineer of Inglewood, Cal. He was appointed city manager in April, 1914.

C. U. Boley has been reappointed city engineer of Sheboygan, Wis. Mr. Boley was first appointed to this office twenty-seven years ago and has served in it continuously to date.

O. W. Peterson has been appointed an assistant by F. C. Herrmann, chief engineer of the Modesto irrigation district, Cal. Mr. Peterson will have charge of the construction work in the district.

W. F. Brooks, highway engineer in the U. S. Office of Public Roads, has been designated to take charge of State aid road work in Lyon, Livingston and other counties in the State of Kentucky.

Charles J. Bennett, State highway commissioner of Connecticut, has been appointed non-resident lecturer on highway engineering at Columbia University, New York City, for the years 1915 and 1916.

John E. Field, State engineer of Colorado, has retired to devote his entire time to the State Land Board, of which he is a member. He is a member of the Field, Fellows & Hinderlider Engineering Company, Denver.

M. L. Klinesmith has resigned as chief engineer of the producing department of the Kern Trading & Oil Company for the purpose of accepting an appointment of a similar nature with the Standard Oil Company in China.

P. M. Jones has been appointed an assistant engineer of the Modesto irrigation district, Cal., to supervise the water measurements being taken along the Tuolunme River for use in the suit of the district against the city of San Francisco.

George Stone, civil engineer of Lockwood, Stone & Company, Boston, spoke on "The Use of Reinforced Concrete in Cotton Manufacturing Plants" at the annual meeting of the National Association of Cotton Manufacturers in Boston, April 29.

H. McL. Harding, consulting engineer, of New York City, specializing in locations, designs and plans for marine and railway terminals, terminal equipment and freight handling machinery, has moved his office from 17 Battery Place to 52 Vanderbilt Avenue.

Leonard C. Wason, president of the Aberthaw Construction Company, Boston, Mass., spoke on "Uses for Concrete Construction by Cotton Manufacturers," at the third session of the annual meeting of the National Association of Cotton Manufacturers in Boston, April 29.

A. A. Weiland, formerly chief engineer of the Arkansas Valley Ditch Association, has been appointed State engineer of Colorado. Mr. Weiland received his education in the University of Colorado and has engaged extensively in hydraulic work. He was appointed chief engineer of the Arkansas Valley Ditch Association in 1910 and has fulfilled the duties of that office in addition to private work as a consulting engineer up to the time of this appointment.

Sydney B. Williamson, chief of construction of the U. S. Reclamation Service, will be in charge of the recently established executive offices of that service at Denver, Col. He will be the executive arm of the service in the field and all matters will go through his office to the headquarters in Washington. Mr. Williamson has served the Government previously in connection with the Panama Canal, having had charge of the construction of the Pacific end of that work. I. D. O'Donnel, supervisor of irrigation will be retained in the field as expert on irrigation work.

A. E. Chandler, irrigation engineer, of Berkeley, has been appointed a member of the California State Water Commission. Mr. Chandler was graduated from the University of California in 1896 and, after being engaged for a period of several years as an instructor in high schools and in the University of California, he was appointed irrigation expert for the U. S. Department of Agriculture. In 1903 he was appointed State engineer of Nebraska, in which capacity he served until 1905 and, in that year, was appointed engineer on land and legal matters in the U. S. Reclamation Service.

Gaylord C. Cummin, city engineer of Dayton, Ohio, was elected city manager of Jackson, Mich., April 21, and will assume the duties of the new office May 1. Mr. Cummin was graduated from Cornell University in 1904 and engaged in railway work on the Oregon & Washington until 1906. Then, as assistant engineer, in the employ of the Lewiston-Clarkston Company, he had charge of the construction of a hydroelectric plant at Clarkston, Wash. From this work he returned to the railway service as locating engineer for the Idaho & Washington. From 1910 to 1911 he engaged in land drainage work in Tennessee, and in 1912 became city engineer of Dayton.

Obituary Notes

W. H. Bancroft, vice-president of the Oregon Short Line and first vice-president of the Salt Lake Route, died at Salt Lake City, April 23.

S. Percy Hooker, State highway commissioner of New Hampshire and highway commissioner of New York State during the administration of Governor Hughes, died in New York City, April 24.

Civil Service Examinations

Examinations Previously Announced

Date		See Eng. Record
May 3-4	Assistant engineer, grade-crossing elimination, Philadelphia; salary, $2500	April 24
May 5	Architectural draftsman, Philadelphia, salary, $1200-$1500	April 24
May 3-10	Architectural draftsman, salary $900-$1200; architectural bridge draftsman, salary $1500; railroad draftsman, salary $1600; Philadelphia	April 24
May 15	Inspector of construction, State of New York; salary $3.50 to $4.50 per day	April 24
June 3	Transitman, Philadelphia; salary $900	April 24
June 4	Second assistant, salary $1000; assistant engineer, salary $4000; Philadelphia	April 24

Miniature Railway Feature of Ohio Northern University Exhibit

A miniature railway that included 50 ft. of track and three bridge models was a feature of the engineering exhibit given by the students of Ohio Northern University, Feb. 26. One of the models was of a ten-panel, 200-ft. span, Pennsylvania through truss bridge and the others, models of a through Pratt truss, six panels, 120-ft. span, and a six panel, 120-ft. span, deck Pratt truss respectively. Other models of interest to civil engineers included several different types of roads, one of a 20-ft. span reinforced-concrete culvert prepared according to the standards of the Ohio State Highway Department, one of a 100-ft. span suspension bridge and one of a concrete road, illustrating the different types of expansion joints.

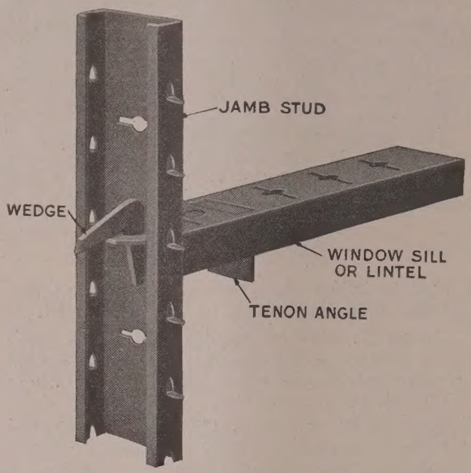
Large Steel Columns Tested for American Bridge Company

A series of steel column tests made by the U. S. Bureau of Standards at the Pittsburgh testing laboratory for the American Bridge Company has been completed and the results are being put into form for a full report. This series consists of eighteen columns fabricated of carbon steel, nickel steel, etc., and with varying end conditions. All but four of the columns failed as a whole, and showed characteristic curving deflection in accordance with the end conditions. In general it can be stated that the columns failed at practically the value of the yield point of the material and showed an elastic limit of about one-half the crippling load. All of these columns were of relatively small length ratio.

Hammer the Only Tool Needed in New Type of Building

A new type of building construction which is designed for rapid erection of multiple buildings, such as small dwellings, stores, etc., is announced by the Trussed Concrete Steel Company, of Youngstown, Ohio. It is claimed that this new construction, which consists of pressed-steel beams and studs combined with Hy-Rib, concrete and stucco, can be completely erected in quicker time and more easily than a wooden frame building, is entirely fireproof and permanent, and compares favorably in cost with any other material.

The small house shown in the accompanying photograph was erected in a few hours by workmen entirely unfamiliar with building construction. The only tool needed is a hammer, as indicated in the second photograph. The detail connections are of the simplest nature, as shown in the standard connection illustrated. All bolting, punching or riveting is eliminated by the use of simple wedges, tenon angles and mortises. The construction includes a variety of beams, channels, joists, rafters, etc., of pressed steel, each manufactured in many sizes. These sections are designed to meet exact requirements, are cut to exact lengths, and detailed so that no further work is necessary at the building site.



DETAILS OF STANDARD CONNECTION

The pamphlet gives full data for standard sizes of Kahn pressed-steel sections, standard connections, rib lath, fire-resisting floors, bearing walls and partitions, etc. Specifications are outlined and complete drawings of details for one and two-story houses furnished. Elevations and plans for miners' cottages and four and five-room bungalows are given, and many illustrations of actual construction and tests are included.

Business Notes

The M. W. Kellogg Company, manufacturers, specializing in power plant piping and radial brick chimneys, will move its offices to-day, from 50 Church St. to 90 West St., New York City.

J. W. Swaren, of The Pelton Water Wheel Company, is giving a lantern slide lecture before the students of various engineering schools on the Pacific Coast. This lecture covers the different phases of a hydraulic development, from water resources to the utilization of the power, and illustrates the most recent types of practice.

Trade Publications

The following companies have recently issued trade literature:

Kerr Turbine Company, Wellsville, N. Y. Bulletin 53, 6 x 9 in., 16 pages, illustrated. Describes "Economy" exhaust steam turbines.

Keystone Grinder & Manufacturing Company, Pittsburgh. Folders showing the various attachments of the Keystone railroad grinder tool.

Pittsburgh Wood Preserving Company, Pittsburgh. Booklet B, 3½ x 6½ in., 8 pages, illustrated. Century creosoted wood block for floors and interior use.

Underwriters' Laboratories, 207 East Ohio Street, Chicago. Catalog, 6 x 9 in., 38 pages, illustrated. Explains the purpose and methods of Underwriters' Laboratories and outlines the organization.

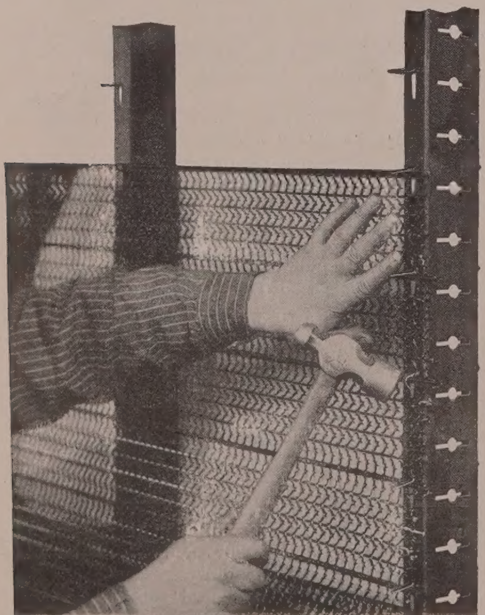
Studebaker, South Bend, Ind. Booklet, 5 x 8 in., 80 pages, illustrated. Deals with methods of keeping streets clean, illustrating equipment so used. The contents contain general information.

Harrison Safety Boiler Works, Philadelphia. Leaflet 18, 6 x 9 in., 48 pages, illustrated. Treats of testing V-notch meters. Reprints of papers describing testing laboratory and experiments are given.

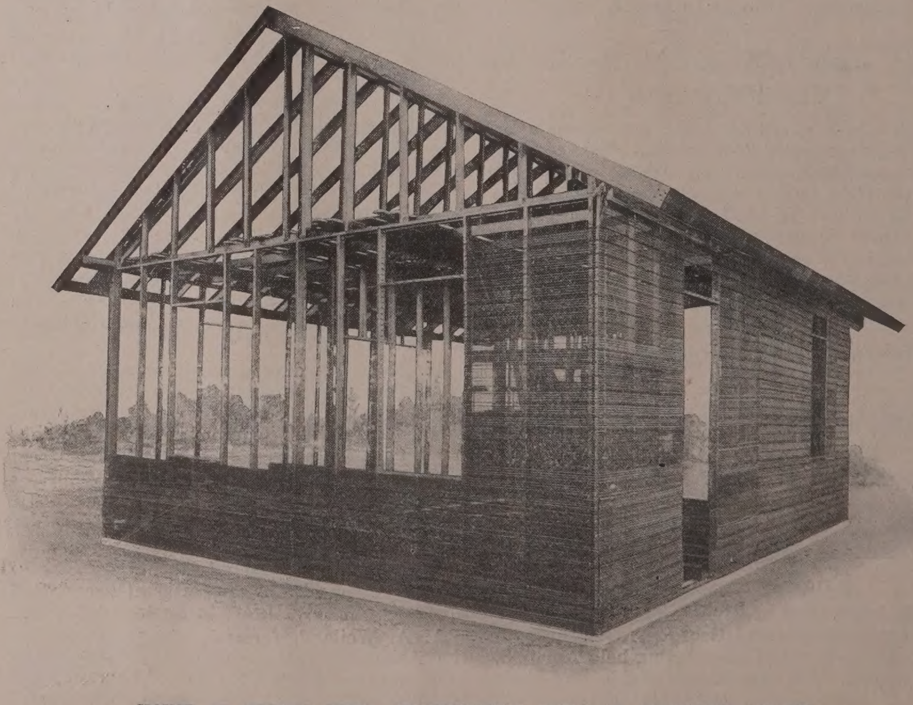
Barber Asphalt Paving Company, Philadelphia. Pamphlet, 6 x 9 in., 8 pages, illustrated. Explains how old roads, brick, macadam or concrete may be economically resurfaced with sheet asphalt and asphaltic concrete.

Hauck Manufacturing Company, 140 Livingston Street, Brooklyn, N. Y. Bulletin 58, 6 x 9 in., 8 pages, illustrated. Deals with several types of kerosene-burner outfits, and surface-asphalt heaters for pavement maintenance.

North Western Expanded Metal Company, 930 Old Colony Building, Chicago. Bulletin 39, Vol. 4, No. 3, 6 x 9 in., 12 pages. illustrated. Contains brief information regarding some recently constructed buildings in Los Angeles in which expanded metal lath was used. An insert presents new data on "Kno-Fur" self-furring expanded metal lath.



A HAMMER IS THE ONLY TOOL REQUIRED



HOUSE OF PRESSED-STEEL CONSTRUCTION BUILT OF STANDARD SHAPES